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CIRCULAR NO. 175

U. S. Naval Observatory, Washington, DC 20392 March 16, 1990

Annular Solar Eclipse of 15-16 January 1991

by

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The U. S. Naval Observatory Eclipse Circulars

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Next Eclipse Circular: Annular Solar Eclipse of 4-5 January 1992 and Total Solar Eclipse of 30 June 1992
Available: early 1991

Annular Solar Eclipse
of
15-16 January 1991

U.S. Naval Observatory Circular 175

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CONTENTS

General Information and Explanation of Contents 4
Overall Eclipse Map, from the *Astronomical Almanac for 1991* 8
Surface Path of the Annular Phase, tabulated by Universal Time (UT) 9
Elements of the Eclipse 10
General Circumstances of the Eclipse 10
Besselian Elements
  Polynomial Form 10
  Tabular Form, tabulated by UT 11
Weather Prospects, *by Jay Anderson* 12
Local Circumstances
  For Points on the Central Line, tabulated by UT 16
  For Geographic Locations (total and partial phases) 18
Limb Corrections
  Explanation 22
  Lunar Profile Correction Diagrams, *by David Herald*
    Tasmania (Australia) 23
    New Zealand 24
  Lunar Limb Profile Diagram 25
Surface Path of the Annular Phase Over Land, tabulated by longitude 26
Path of the Central Line at Flying Altitudes, tabulated by UT 30
Corrections to UT and Latitude for Elevations Above Sea Level 32
Detailed Maps of the Path Over Land
  Legend 33
  W. Australia (Perth) 34
  W. Australia (Mount Barker) 35
  W. Australia (Esperance) 36
  Tasmania 37
  New Zealand (South Island) 38
  New Zealand (North Island) 39

GENERAL INFORMATION

An annular eclipse of the Sun will occur on Tuesday, 15 January 1991 and Wednesday, 16 January 1991. It will be followed by an associated penumbral lunar eclipse on 30 January. The central path of this annular eclipse will include well-populated areas in southwestern Australia, Tasmania, and New Zealand. At maximum, approximately 86.4% of the Sun's disk will be obscured and the maximum duration of annularity will be about 7m 49s. Because the track will cross the International Date Line, by local times the eclipse will occur on the morning of 16 January at the beginning of the path and occur on the evening of 15 January at the end of the path.

This eclipse belongs to saros series number 131. The last preceding eclipse in this series was the annular solar eclipse of 4 January 1973; the next eclipse in the series will be the annular solar eclipse of 26 January 2009.

Prior to this eclipse, an annular solar eclipse occurred on 26 January 1990 over Antarctica, and a total solar eclipse will occur on 22 July 1990 over Finland, the arctic regions of the Soviet Union, and the Aleutian Islands. The next solar eclipse following the 15-16 January 1991 event will be the long total eclipse of 11 July 1991.

PATH AND VISIBILITY

Inexperienced observers are cautioned to observe only by use of projected images, and not to use any method which would cause them to look directly at the Sun.

At approximately 22h 00m UT on 15 January 1991, the center of the umbra of the Moon's shadow will touch the Earth at sunrise at a point in the Indian Ocean off the west coast of Australia. At this time, the annular phase will last about 5m 35s. First landfall of the center line will occur approximately 30 seconds later at a point on the southwestern coast of Australia, between the cities of Fremantle and Rockingham. During its passage over southwestern Australia, the central path will include the cities of Perth, Fremantle, Bunbury, Collie, Wagin, Narrogin, Busselton, Katanning, Esperance, and Mount Barker. The center line will leave southwestern Australia and enter the Southern Ocean at approximately 22h 02m UT at a point near the town of Hopetoun. At this time, the eclipsed Sun will be located only about 11° above the horizon, the duration of the central phase will have increased to approximately 5m 52s, and about 84.3% of the Sun's disk will be obscured for an observer on the center line. The central path will be approximately 343 km wide.

The center line will make its next landfall on the island of Tasmania, at approximately 22h 21m 30s UT. At this time, the Sun's altitude will have increased to about 34°, the annular phase will last approximately 6m 41s, and about 85.3% of the Sun will be obscured for a center line observer. The central path, decreasing in width from about 307 km to about 302 km over the island, will include all but the southern third of Tasmania. Neighboring King Island, Cape Barren Island, and most of Flinders Island will be within the path; the Australian mainland will lie just to the north of the track. The Tasmanian cities of Launceston, Devonport, Burnie, Queenstown, and Smithton will lie within the path of the annular eclipse; Hobart will lie just to the south of the path. The center line will leave Tasmania and enter the Tasman Sea at approximately 22h 26m UT.

The center line then will cross the Tasman Sea heading for New Zealand, reaching the South Island just south of Cape Foulwind, at about 23h 05m 30s UT. At this time, the Sun will be located at an altitude of about 61°, the duration of the central phase will have increased to approximately 7m 37s, and about 86.2% of the Sun's disk will be obscured for an observer on the center line. The South Island cities of Nelson, Blenheim, Richmond, Hokitika, and Westport will lie within the central path. The northern limit will pass over the Tasman Sea and Cook Strait, and hence, will be inaccessible from the South Island. The center line will reach the North Island, near Wellington, at about 23h 13m UT. At this time, the Sun's altitude will be about 64°, the central phase will last approximately 7m 42s, and the obscuration will be about the same as it was over the South Island. The northern limit of the path will pass over the North Island, while the southern limit will pass over water. In addition to Wellington, the North Island cities of Hastings, Lower Hutt, Palmerston North, Masterton, and Feilding will lie within the track. The cities of Napier and Wanganui will lie very close to the northern limit. The width of the central path will decrease from about 279 km to about 275 km during its passage over New Zealand. The longest duration of annular eclipse (about 7m 49s) will occur at approximately 23h 39m UT, at a point on the center line east of the North Island.

After leaving New Zealand, the central path will take a more northward turn across the South Pacific Ocean, heading towards the islands of French Polynesia. The small islands of Rurutu, Anaa, Makemo, and Raroia are among the largest islands that will lie within the central path. The track will pass just south of Tahiti and just north of Tubuai on its passage through the island groups.

The center line will leave the Earth at sunset at approximately 1h 46m UT on 16 January, at a point over the South Pacific Ocean west of the Galapagos Islands.

Partial phases of the eclipse, of magnitude decreasing with the distance from the path of the central phase, will be visible over all of Australia and New Zealand, portions of Indonesia and Antarctica, and most of the South Pacific Ocean.

CHANGE IN CONTENTS

Detailed maps are provided for the central path over Australia, including Tasmania, and New Zealand. All of the maps are on the same scale (see *Detailed Path Maps* below). No maps are provided for the path through the islands of French Polynesia; however, for observers interested in plotting this path themselves, coordinates are provided in the table *Surface Path of the Annular Phase Over Land*. Continuing a change made in *Circular 173*, the table giving the central path as a function of longitude at flying altitudes has been replaced by a table providing the path of the central line at flying altitudes as a function of time. No refraction corrections have been applied in the table of local circumstances for geographic locations. All locations are assumed to be on the surface of the reference ellipsoid, except for the observatories, whose heights were included in the calculations (see *Local Circumstances* below). No sky diagrams have been provided for this eclipse.

PARAMETERS AND CORRECTIONS

The predictions in this Circular are derived from the solar and lunar data contained in the DE200/LE200 ephemeris developed jointly by the Jet Propulsion Laboratory and the U. S. Naval Observatory for use in the *Astronomical Almanac* for 1984 and after. Corrections have been applied to both the lunar latitude and longitude to help account for the difference between the Moon's center of figure and the center of motion (see *Elements of the Eclipse* elsewhere in this *Circular*). In order to best take into account the rough limb of the Moon, the value of k = 0.2725076 for the ratio of the radius of the lunar profile to the Earth's radius is used throughout the calculations. The International Astronomical Union (IAU) adopted this value for k in August 1982. The observer then is required to make the final limb corrections, as described elsewhere in this *Circular*. As usual, all time arguments are in Universal Time (UT), using the best value of ΔT [the difference between Terrestrial Dynamical Time (TDT) and UT] available at the time of preparation (see *Elements of the Eclipse*). The convention of longitude positive east of Greenwich is used throughout this *Circular*.

DETAILED PATH MAPS

The detailed maps provided in this *Circular* are presented on portions of the Defense Mapping Agency's Operational Navigation Charts (ONC), scale 1:1,000,000, Lambert Conformal Conic Projection. All of the maps have been reduced to 50% of original size, enlarging the scale from 15.78 miles/inch to 31.56 miles/inch. A small arrow on each map, located on the central line at a time mark, indicates the azimuth of the Sun at that point. The altitude of the Sun at the point is given in the accompanying label. For an explanation of the maps, see *Estimating Second and Third Contacts* below.

LOCAL CIRCUMSTANCES

DEFINITIONS. *First* and *fourth contacts* are, respectively, the beginning and the end of the partial phase. *Second* and *third contacts* are, respectively, the beginning and end of the central phase, if it occurs at the given location. *Duration* is the time interval between second and third contacts. Dot leaders indicate that a phenomenon occurs below the horizon for a given location.

The *position angle* of a point of contact on the solar limb is measured eastward (counterclockwise) around the solar limb. P is the position angle measured from the north point on the limb; V is the position angle measured from the vertex point. The *north point* lies on the great circle arc drawn from the north celestial pole to the center of the solar disk; the *vertex point* lies on the great circle arc drawn from the zenith to the center of the solar disk. If the angle is listed as negative, add 360°.

The *azimuth* of the Sun is measured along the horizon clockwise from the north point eastward to the foot of the great circle arc drawn from the zenith through the center of the solar disk down to the horizon. If it is listed as negative, either add 360° or measure westward from north.

The *magnitude* of the eclipse is the fraction of the apparent diameter of the solar disk covered by the Moon at the time of greatest phase, expressed in units of the solar diameter.

Degree of obscuration is the fraction (per cent) of the area of the apparent solar disk obscured by the Moon at maximum eclipse.

TABLES. In addition to the table of local circumstances on the center line, a table of accurate local circumstances for a list of selected geographic locations is provided. The locations were chosen for their position near the central path, general geographic distribution, and size of population. Coordinates were taken from *The Times Atlas* or read from the detailed maps in this *Circular*. All coordinates are approximate and assumed to be on the surface of the reference ellipsoid, except for the tabulated observatories, whose coordinates (including height) were obtained from the *Astronomical Almanac's* observatory list. The printed circumstances correspond to the printed coordinates, in case there should be an error in identification or coordinates. It is often difficult in preparing maps and local circumstances to ascertain the correct name and spelling for a given location. *Therefore, the information presented here is for location purposes only; it is not authoritative, and does not imply recognition of the status of any area by the United States Government.* The tabulated local circumstances are not corrected for refraction. For the user who wishes to calculate local circumstances, the elements of conjunction, general circumstances, and Besselian Elements for UT arguments are provided. The Besselian Elements are given as usual in tabular form, and also in polynomial form. Precepts for the calculations of local circumstances can be found in the Explanation of the *American Ephemeris and Nautical Almanac* for 1980 or earlier years.

ESTIMATING FIRST AND FOURTH CONTACTS. Beginning and end of the partial phase, or first and last contacts, can be estimated using the one-page overall map reproduced in this *Circular* from the *Astronomical Almanac*. The dashed lines show the surface outline of the Moon's penumbra at a time interval of 30 minutes. The short dashes show the leading edge, the long dashes show the trailing edge. First contact occurs when the leading edge passes over the location in question, last contact occurs when the trailing edge passes. Duration is the time difference between contacts. The time halfway between is the middle of the eclipse. This is near the time of maximum eclipse, but not necessarily identical. At a given location, one need only estimate the intermediate position of the penumbra's edge between the starting and ending lines on either side and thus the time of the contact. For observers within the elongated "teardrop" curves to the extreme east and west, part of the eclipse occurs below the horizon.

ESTIMATING SECOND AND THIRD CONTACTS. Low precision times of second and third contacts in the central path can also be estimated. The central path over land is shown on a series of detailed maps in this *Circular*. On the maps, the heavy solid lines mark the northern and southern limits of the predicted path. Each dashed line represents the projection of the diameter of the umbra, joining the northern and southern limits and central point for the indicated instant, at which all points on the dashed line experience maximum eclipse. Elsewhere in the Circular is a table of local circumstances for points on the central line. Use the maps and table as follows. Find on the maps the location in the path for which you want local circumstances. From the one-minute cross lines on either side, estimate or measure the time t_0 when the projected axis line of the umbra will pass over the point. Turn to the table of *Local Circumstances for Points on the Central Line*. Find where the time t_0 fits into the first column on each page. Using the appropriate fraction of the time interval, read across both pages and interpolate the times of second and third contacts, the duration (D), and the width of the path (a). Make a note of the angles P and V for each contact (for use as described in the next section), and also the altitude (a) and the azimuth (A) of the Sun at maximum eclipse. Turn back to the map. If you mark the cross lines for the second and third contact times, you can see the breadth of the projected shadow. Now draw a line through the observing point perpendicular to the path. Estimate or measure how far the point is from the center of the path and call this quantity b (a and b must be in the same units). Next compute the approximate duration (T) for the selected location by:

$$T = D\sqrt{1 - (2b/a)^2}$$

Then, the time of second contact is approximately $t_0 - T/2$, third contact $t_0 + T/2$.

ESTIMATING POSITION ANGLES. The lunar limb profile for this eclipse is provided elsewhere in this *Circular*. For locations in the central path, the predicted times and position angles of contacts are based on the Moon's mean limb (the smooth circle). Correction for limb irregularities is discussed later. In working with this construction, remember that the position angles are given for the solar disk, which is observable, but corrections are based on features on the lunar disk, shown in the diagram. The two nearly coincide between second and third contacts, so it is adequate to plot angles pertaining to the Sun on the lunar diagram. However, this is not the case for first and fourth contacts. You may find it convenient to use a transparent overlay with a circle of radius three inches.

For each second or third contact to be sketched for a location given in a table, take from the table the time of contact (t_c), the angles P and V, and the altitude (a) and the azimuth (A) of the Sun at maximum eclipse, as described above. Convert the time of contact to hours and decimals. The topocentric position angle of the lunar axis (C) is a function of time, the position of the Moon and the Sun, and the location of the observer. For this eclipse, compute C from the following equation. In this equation, if t_c occurs on 16 January, then $t_c = t_c + 24$ hours:

$$C = 355°.71 - 0°.186\,t_c + 0°.39 \cos a \sin (P - V).$$

On the diagram, N marks lunar north. Using the four direction tick marks, find the center of the circle. Draw a line from the center through N. Next measure the angle C westward (clockwise) from N. Mark the point on the mean limb and draw a line from the center through it. This points to the Earth's north celestial pole. From this line, measure back the angle P eastward (counterclockwise) to find the point of contact on the mean limb. Draw a line from the center out through that point. Finally, from that line, measure through the angle V westward (clockwise). Draw a line from the center through this point. This line points to the observer's zenith. Now you can visualize events as follows: Facing in the direction of the Sun's azimuth (A), measured in degrees positively from the north point of the horizon around clockwise to the east, hold the diagram up at arm's length at the altitude (a) of the Sun at maximum eclipse, and turn it so that the line pointing to the zenith points straight up. The line to the north point of the disk will point to celestial north for the observing site, and the point of contact at the limb will be at its correct apparent orientation.

To get position angles for locations not listed in the tables, follow the directions given above for estimating second and third contacts, and plot the points of second and third contacts for the interpolated (P,V) *on the center line*. Draw a line connecting the two contacts on the mean limb. It should pass through the center of the disk in approximately an east/west direction. In order to transfer this line of motion to a parallel one for a point off the center line, draw or construct a perpendicular diameter, which runs approximately north/south. Taking (2b/a) from the calculation of duration, measure off (2b/a) × radius from the center of the circle along the north/south diameter in the same direction as the observing site is from the center line. Mark the point on the diameter, and draw or construct perpendicular to it, another line parallel to the line through the central line contact points. This new line will intersect the mean limb at approximately the points of contact. The western point is for second contact, the eastern is for third contact. This construction is not as accurate as a full calculation, but adequate for field estimates.

OBSERVATIONS

Precise observations of the second and third contact times, at any part of the path, but especially the northern and southern limits, are needed and requested. Since precise coordinates of the observer must be determined, reports of such timings should indicate location information, such as nearest settlement, roads to the site, distance to nearby landmarks or identifiable buildings and the nearest road intersection, distance from the center of the road, etc. The method of timing also should be described. Precision requirements are to within 0.5 second of time and 50 feet in location. Please send reports to:

Nautical Almanac Office
U. S. Naval Observatory
Washington, DC 20392-5100 USA

Inexperienced observers are cautioned to observe only by use of projected images, and not to use any method which would cause them to look directly at the Sun.

Information on photography, direct viewing, and projection methods may be found in the following publications:

"Safe Solar Filters," by B. Ralph Chou, *Sky & Telescope*, August 1981, p. 119.

"Observing the Sun in Safety," by J. C. D. Marsh, *J. Brit. Astron. Assoc.*, 1982, **92**, 6, p. 237.

Astrophotography Basics, Kodak Customer Service Pamphlet P-150, 1988.

A Complete Manual of Amateur Astronomy, by P. Clay Sherrod, Prentice-Hall, 1981.

Eclipse, by Bryan Brewer, 1979.

Observe: Eclipses, by R. Sweetsir and M. Reynolds, Astronomical League, 1979.

FURTHER INFORMATION

Inquiries concerning special calculation of local circumstances and extensions or modifications of data in this publication should be directed to the Nautical Almanac Office at the address given in the previous section.

ACKNOWLEDGEMENTS

The weather prospects section was contributed by meteorologist Jay Anderson of the Prairie Weather Centre; Winnipeg, Manitoba, Canada; (204) 983-4513.

The charts to correct contact times for the effects of lunar limb features were contributed by David Herald, Canberra, A.C.T., Australia.

The detailed maps are presented on portions of the Defense Mapping Agency's (DMA) Operational Navigation Charts (ONC) Q-12, R-11, R-13, R-15, S-11, and S-13. Information concerning availability, purchase prices, and ordering instructions can be obtained by calling DMA at 1-800-826-0342 from anywhere in the continental United States, (301) 227-2495 from elsewhere, or by writing:

Director
Defense Mapping Agency CSC
ATTN: PMA
Washington, DC 20315-0010 USA

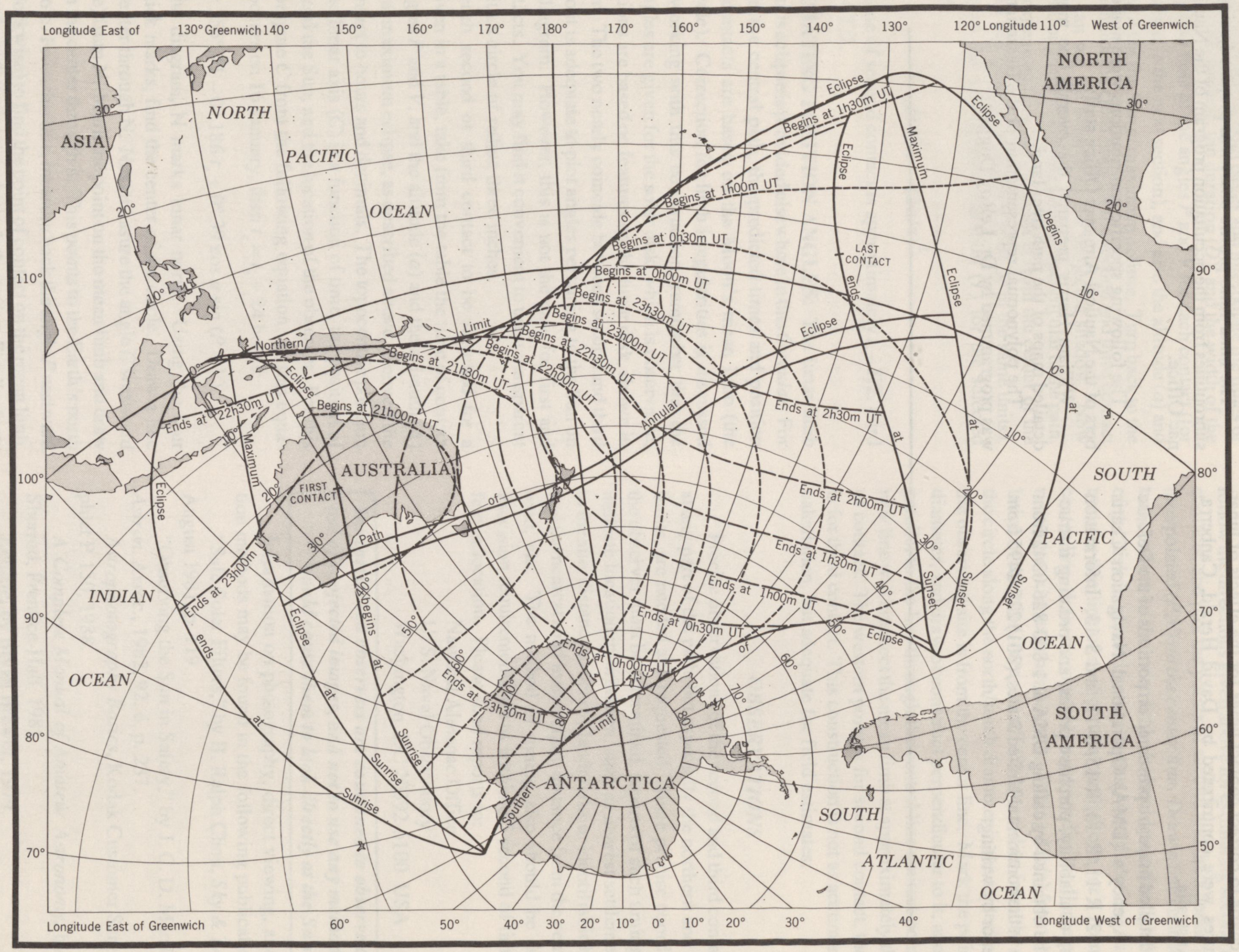
The lunar limb profile chart was prepared using software subroutines from the occultation program of the Nautical Almanac Office.

The following specific contributions were made by members of the Nautical Almanac Office staff:

William Harris prepared the overall line map and the detailed maps of the path over land.

The polynomial representation of the Besselian elements was programmed by Dr. LeRoy Doggett.

ANNULAR SOLAR ECLIPSE OF 1991 JANUARY 15-16


Longitude East of
130° Greenwich 140°
150°
160°
170°
180°
170°
160°
150°
140°
130°
120° Longitude 110°
West of Greenwich
ASIA
NORTH
PACIFIC
OCEAN
NORTH
AMERICA
AUSTRALIA
FIRST
CONTACT
LAST
CONTACT
INDIAN
OCEAN
SOUTH
PACIFIC
OCEAN
SOUTH
AMERICA
ANTARCTICA
SOUTH
ATLANTIC
OCEAN
Northern Limit
Southern Limit
Path of Annular Eclipse
Maximum Eclipse
Eclipse begins at Sunrise
Eclipse ends at Sunrise
Eclipse begins at Sunset
Eclipse ends at Sunset
Begins at 21h00m UT
Begins at 21h30m UT
Begins at 22h00m UT
Begins at 22h30m UT
Begins at 23h00m UT
Begins at 23h30m UT
Begins at 0h00m UT
Begins at 0h30m UT
Begins at 1h00m UT
Begins at 1h30m UT
Ends at 22h30m UT
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Ends at 23h30m UT
Ends at 0h00m UT
Ends at 0h30m UT
Ends at 1h00m UT
Ends at 1h30m UT
Ends at 2h00m UT
Ends at 2h30m UT
110°
100°
90°
80°
70°
90°
80°
70°
60°
50°
30°
20°
10°
0°
10°
20°
30°
40°
50°
60°
70°
80°
Longitude East of Greenwich
60°
50°
40°
30°
20°
10°
0°
10°
20°
30°
40°
Longitude West of Greenwich

SURFACE PATH OF THE ANNULAR PHASE

U.T.	Northern Limit		Central Line		Southern Limit	
	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
	° ′	° ′	° ′	° ′	° ′	° ′
Limits	−28 30.7	+110 37.3	−29 51.9	+109 35.6	−31 13.6	+108 31.5
h m						
22 00	−31 53.5	+119 18.5	−30 46.8	+111 54.7	.. .. .	... .. .
22 01	−32 53.4	+122 01.4	−32 56.1	+117 32.9	.. .. .	... .. .
22 02	−33 40.0	+124 12.2	−34 02.5	+120 34.7	−33 49.6	+115 18.5
22 04	−34 52.3	+127 44.8	−35 33.1	+124 55.2	−36 01.8	+121 26.9
22 05	−35 21.9	+129 16.0	−36 08.0	+126 40.7	−36 45.4	+123 35.4
22 10	−37 13.8	+135 31.2	−38 14.1	+133 37.2	−39 11.5	+131 28.3
22 15	−38 30.0	+140 30.7	−39 37.0	+138 59.7	−40 42.8	+137 18.3
22 20	−39 25.0	+144 48.2	−40 36.0	+143 33.8	−41 46.6	+142 11.2
22 25	−40 05.1	+148 37.9	−41 18.7	+147 36.8	−42 32.2	+146 29.1
22 30	−40 33.8	+152 07.3	−41 49.0	+151 17.6	−43 04.5	+150 22.4
22 35	−40 53.2	+155 20.8	−42 09.5	+154 41.2	−43 26.2	+153 57.1
22 40	−41 04.8	+158 21.4	−42 21.7	+157 50.9	−43 39.1	+157 16.8
22 45	−41 09.7	+161 11.0	−42 26.8	+160 48.9	−43 44.5	+160 23.8
22 50	−41 08.7	+163 51.1	−42 25.6	+163 36.8	−43 43.3	+163 20.1
22 55	−41 02.4	+166 22.9	−42 19.0	+166 15.7	−43 36.3	+166 06.7
23 00	−40 51.4	+168 47.1	−42 07.4	+168 46.6	−43 24.2	+168 44.7
23 05	−40 36.0	+171 04.6	−41 51.2	+171 10.2	−43 07.3	+171 14.9
23 10	−40 16.5	+173 15.9	−41 30.9	+173 27.2	−42 46.1	+173 38.0
23 15	−39 53.4	+175 21.4	−41 06.8	+175 38.1	−42 20.9	+175 54.5
23 20	−39 26.9	+177 21.8	−40 39.2	+177 43.3	−41 52.1	+178 05.0
23 25	−38 57.1	+179 17.3	−40 08.2	+179 43.4	−41 19.9	−179 50.1
23 30	−38 24.3	−178 51.6	−39 34.1	−178 21.3	−40 44.5	−177 50.4
23 35	−37 48.6	−177 04.6	−38 57.1	−176 30.4	−40 06.1	−175 55.5
23 40	−37 10.2	−175 21.3	−38 17.3	−174 43.6	−39 24.9	−174 04.9
23 45	−36 29.1	−173 41.4	−37 34.8	−173 00.4	−38 41.1	−172 18.3
23 50	−35 45.5	−172 04.6	−36 49.8	−171 20.5	−37 54.6	−170 35.2
23 55	−34 59.4	−170 30.5	−36 02.3	−169 43.6	−37 05.7	−168 55.4
0 00	−34 10.9	−168 58.9	−35 12.4	−168 09.4	−36 14.4	−167 18.5
0 05	−33 20.0	−167 29.4	−34 20.2	−166 37.4	−35 20.8	−165 44.0
0 10	−32 26.8	−166 01.6	−33 25.6	−165 07.4	−34 24.8	−164 11.6
0 15	−31 31.3	−164 35.3	−32 28.8	−163 38.9	−33 26.6	−162 40.9
0 20	−30 33.4	−163 10.1	−31 29.6	−162 11.6	−32 26.0	−161 11.5
0 25	−29 33.1	−161 45.5	−30 28.0	−160 45.1	−31 23.2	−159 42.9
0 30	−28 30.4	−160 21.3	−29 24.0	−159 18.9	−30 17.9	−158 14.8
0 35	−27 25.1	−158 56.8	−28 17.5	−157 52.5	−29 10.2	−156 46.4
0 40	−26 17.2	−157 31.7	−27 08.4	−156 25.5	−27 59.8	−155 17.4
0 45	−25 06.5	−156 05.3	−25 56.5	−154 57.2	−26 46.8	−153 47.1
0 50	−23 52.8	−154 37.1	−24 41.6	−153 26.9	−25 30.7	−152 14.7
0 55	−22 35.8	−153 06.2	−23 23.5	−151 53.8	−24 11.4	−150 39.3
1 00	−21 15.3	−151 31.6	−22 01.8	−150 16.9	−22 48.5	−148 60.0
1 05	−19 50.8	−149 52.4	−20 36.1	−148 35.0	−21 21.6	−147 15.3
1 10	−18 21.6	−148 06.9	−19 05.7	−146 46.5	−19 49.9	−145 23.5
1 15	−16 47.1	−146 13.1	−17 29.8	−144 49.2	−18 12.5	−143 22.3
1 20	−15 06.1	−144 08.5	−15 47.2	−142 40.1	−16 28.2	−141 08.3
1 25	−13 16.8	−141 48.8	−13 56.0	−140 14.6	−14 34.8	−138 36.4
1 30	−11 16.7	−139 07.6	−11 53.3	−137 25.3	−12 29.0	−135 37.7
1 35	− 9 00.9	−135 53.0	− 9 33.2	−133 58.0	−10 03.9	−131 55.0
1 40	− 6 18.6	−131 38.9	− 6 42.3	−129 18.8	− 7 01.2	−126 41.8
1 42	− 5 00.4	−129 26.3	− 5 16.8	−126 45.7	− 5 24.1	−123 36.1
1 44	− 3 27.7	−126 38.5	− 3 28.8	−123 16.4	− 2 59.0	−118 26.8
1 45	− 2 31.6	−124 50.7	− 2 14.5	−120 40.3	.. .. .	... .. .
Limits	+ 1 49.8	−115 08.4	+ 0 27.4	−114 17.4	− 0 55.8	−113 25.3

For duration, path width, obscuration, and altitude and azimuth of the Sun, please see page 16, **Local Circumstances for Points on the Central Line**

ELEMENTS OF THE ECLIPSE

U.T. of geocentric conjunction in right ascension, January $15^d\ 23^h\ 43^m\ 30^s.814$

Julian Date = 2448272.4885510828

	h m s		s
R.A. of Sun and Moon	19 49 09.500	Hourly motions	10.736 and 125.389
ΔT	57.281		
	° ′ ″		′ ″
Declination of Sun	−21 04 25.58	Hourly motion	+ 0 27.88
Declination of Moon	−21 19 54.69	Hourly motion	+ 8 15.61
Equatorial hor. par. of Sun	8.94	True semidiameter of Sun	16 15.5
Equatorial hor. par. of Moon	54 37.58	True semidiameter of Moon	14 53.1
Lunar figure offset, long.	+ 0.53		
Lunar figure offset, lat.	− 0.29		

CIRCUMSTANCES OF THE ECLIPSE

	U.T. d h m	Longitude ° ′	Latitude ° ′
Eclipse begins	January 15 20 51.0	+129 29.7	− 24 29.0
Central eclipse begins	15 21 59.9	+109 35.6	− 29 51.9
Central eclipse at local apparent noon	15 23 43.5	− 173 30.7	− 37 47.7
Central eclipse ends	16 01 45.9	− 114 17.4	+ 0 27.4
Eclipse ends	16 02 54.8	− 133 36.8	+ 5 57.0

Longitudes are measured positive east of Greenwich

BESSELIAN ELEMENTS, POLYNOMIAL FORM

The equations below represent simple least-squares fits to the tabular Besselian Elements.

Let $t = (\text{U.T.} - 20^h)$ in units of hours; if t is negative, add 24^h.

These equations are valid over the range $0^h.800 \leq t \leq 7^h.075$. Do not use t outside the given range, and do not omit any terms in the series.

$$
\begin{aligned}
x &= -1.82592352 + 0.49010146\,t + 0.00003429\,t^2 - 0.00000563\,t^3\\
y &= -0.81546704 + 0.14199985\,t + 0.00016699\,t^2 - 0.00000179\,t^3\\
\sin d &= -0.36000510 + 0.00011951\,t + 0.00000014\,t^2\\
\cos d &= 0.93295029 + 0.00004618\,t + 0.00000002\,t^2\\
\mu &= 117.64169097 + 14.99762461\,t + 0.00000226\,t^2\\
\text{Radius penumbra} &= 0.57183464 + 0.00000546\,t - 0.00001013\,t^2\\
\text{Radius umbra} &= 0.02532205 + 0.00000537\,t - 0.00001006\,t^2
\end{aligned}
$$

BESSELIAN ELEMENTS

U.T.	Intersection of Axis of Shadow with Fundamental Plane		Direction of Axis of Shadow			Radius of Shadow on Fundamental Plane	
	x	*y*	sin *d*	cos *d*	μ	Penumbra	Umbra
h m					°		
20 30	−1.580865	−0.744426	−0.359945	0.932973	125.14050	0.571835	+0.025322
20 40	−1.499176	−0.720727	−0.359925	0.932981	127.64011	0.571834	+0.025321
20 50	−1.417485	−0.697019	−0.359905	0.932989	130.13971	0.571832	+0.025320
21 00	−1.335793	−0.673302	−0.359885	0.932996	132.63932	0.571830	+0.025317
21 10	−1.254101	−0.649576	−0.359865	0.933004	135.13892	0.571827	+0.025315
21 20	−1.172407	−0.625841	−0.359846	0.933012	137.63853	0.571824	+0.025311
21 30	−1.090713	−0.602098	−0.359826	0.933020	140.13813	0.571820	+0.025307
21 40	−1.009019	−0.578345	−0.359806	0.933027	142.63774	0.571816	+0.025303
21 50	−0.927324	−0.554584	−0.359786	0.933035	145.13734	0.571811	+0.025298
22 00	−0.845628	−0.530814	−0.359766	0.933043	147.63695	0.571805	+0.025293
22 10	−0.763933	−0.507035	−0.359746	0.933050	150.13655	0.571799	+0.025286
22 20	−0.682238	−0.483248	−0.359726	0.933058	152.63616	0.571792	+0.025280
22 30	−0.600544	−0.459452	−0.359706	0.933066	155.13577	0.571785	+0.025273
22 40	−0.518849	−0.435647	−0.359685	0.933074	157.63537	0.571777	+0.025265
22 50	−0.437155	−0.411834	−0.359665	0.933081	160.13498	0.571769	+0.025256
23 00	−0.355463	−0.388013	−0.359645	0.933089	162.63459	0.571760	+0.025247
23 10	−0.273770	−0.364183	−0.359625	0.933097	165.13419	0.571750	+0.025238
23 20	−0.192079	−0.340345	−0.359605	0.933104	167.63380	0.571740	+0.025228
23 30	−0.110390	−0.316498	−0.359585	0.933112	170.13340	0.571730	+0.025217
23 40	−0.028701	−0.292644	−0.359565	0.933120	172.63301	0.571718	+0.025206
23 50	+0.052986	−0.268781	−0.359545	0.933128	175.13262	0.571707	+0.025195
0 00	+0.134671	−0.244910	−0.359525	0.933135	177.63223	0.571694	+0.025182
0 10	+0.216354	−0.221031	−0.359505	0.933143	180.13183	0.571681	+0.025169
0 20	+0.298035	−0.197144	−0.359485	0.933151	182.63144	0.571668	+0.025156
0 30	+0.379714	−0.173249	−0.359465	0.933159	185.13105	0.571654	+0.025142
0 40	+0.461391	−0.149346	−0.359445	0.933166	187.63066	0.571639	+0.025128
0 50	+0.543066	−0.125435	−0.359425	0.933174	190.13026	0.571624	+0.025113
1 00	+0.624737	−0.101516	−0.359405	0.933182	192.62987	0.571608	+0.025097
1 10	+0.706406	−0.077590	−0.359385	0.933190	195.12948	0.571592	+0.025081
1 20	+0.788072	−0.053655	−0.359364	0.933197	197.62909	0.571575	+0.025064
1 30	+0.869735	−0.029713	−0.359344	0.933205	200.12870	0.571558	+0.025047
1 40	+0.951395	−0.005764	−0.359324	0.933213	202.62830	0.571540	+0.025029
1 50	+1.033051	+0.018193	−0.359304	0.933221	205.12791	0.571521	+0.025010
2 00	+1.114704	+0.042158	−0.359284	0.933228	207.62752	0.571502	+0.024991
2 10	+1.196353	+0.066130	−0.359264	0.933236	210.12713	0.571483	+0.024972
2 20	+1.277998	+0.090110	−0.359244	0.933244	212.62674	0.571462	+0.024952
2 30	+1.359639	+0.114097	−0.359224	0.933252	215.12635	0.571442	+0.024931
2 40	+1.441276	+0.138092	−0.359203	0.933259	217.62596	0.571420	+0.024910
2 50	+1.522908	+0.162093	−0.359183	0.933267	220.12557	0.571398	+0.024888
3 00	+1.604536	+0.186102	−0.359163	0.933275	222.62517	0.571376	+0.024865
3 10	+1.686159	+0.210118	−0.359143	0.933283	225.12478	0.571353	+0.024843
3 20	+1.767778	+0.234141	−0.359123	0.933290	227.62439	0.571329	+0.024819

tan f_1	0.004754	
tan f_2	0.004731	
μ'	0.261758	radians per hour
d'	+0.000129	radians per hour

WEATHER PROSPECTS

Jay Anderson
Prairie Weather Centre
900-266 Graham Ave
Winnipeg, MB CANADA R3C 3V4

OVERVIEW

Girding the Earth at about thirty degrees from the equator in both the north and south hemispheres is a necklace of semi-permanent anticyclones know in sailing lore as the "horse latitudes". It is the Earth's fair-weather zone with bright sunny days, light winds, and low humidities. Over land, it encompasses the planet's greatest deserts.

In January the band of anticyclones stretches from the south coast of Australia to New Zealand's North Cape, along the morning path of the eclipse (Figure 1). January is the southern hemisphere's mid-summer, with abundant sunshine to tempt the eclipse-chaser, even for an annular event. In New Zealand, where the track is far enough south to catch the fringes of passing lows travelling in the westerly winds of the "roaring forties", January is the sunniest month and eclipse-viewing prospects are good.

Departing New Zealand, the eclipse track heads northeastward, crossing the speckled cloudiness of the trade wind belt as it moves through the islands of French Polynesia. Finally, as sunset brings an end to the spectacle of a ringed sun, the shadow centre moves into the doldrums west of the Galapagos Islands, nudging past the equator to touch the northern hemisphere.

AUSTRALIA

The anticyclones which control southern Australia's weather are not stationary high pressure systems, but instead move slowly from west to east in a cycle which repeats every five or six days. This causes a regular progression of changing winds over the eclipse track, with each new direction bringing a characteristic pattern of temperature and cloudiness. The weak low pressure trough between the highs may bring a temporary cloudiness and occasional showers or thundershowers. The usual path of the summer anticyclones tends to pass south of Perth and across Tasmania.

An approaching high, moving along its characteristic path, brings southwest winds and maritime air onto the eclipse track. This air is seldom moist enough to carry more than light clouds to the southwest of the continent. Over Tasmania the added effect of orographic lifting of the air flow is sufficient to bring additional condensation and the formation of heavier cloud on the west side of the island. The east side, in a downhill flow and sheltered from the main force of the winds, is drier and sunnier (Figure 2). The cloudier west side of Tasmania is also a consequence of the island's southerly location, which places it more frequently in the belt of westerly winds.

As the high passes, winds turn into the northeast, carrying hot and dry continental air from the interior onto the southwest coast. Temperatures may rise above 40C and the bright sunny skies may be tinged with dust and smoke, depending on the dryness of the year. Over Tasmania, northeasterlies do not flow off the continent but instead tap the maritime air of the Tasman Sea, bringing higher levels of cloudiness than the same winds on Australia's west coast.

Sea breeze winds develop very strongly over the Australian west coast, and may even overcome the local flow which is driven by the pressure gradient around the nearest anticyclone. The breezes can reach very far inland, sometimes over 350 kilometres by early evening, and bring a welcome cooling to the heat of the afternoon. On the west coast the "Fremantle Doctor", a sea breeze well known to America's Cup enthusiasts, can follow the eclipse track inland almost as far as Narrogin. The "Albany Doctor" and the "Esperance Doctor", both of which come up from the south, may reach northward to cover the rest of the eclipse track across southwest Australia, though not normally until late in the day. Sea breeze circulations can begin as early as 9 a.m. when gradient winds are light, or be held off until mid-afternoon if opposing flows of moderate strength linger from a passing high. Little cloudiness usually accompanies these winds.

The contrast between the hot northerly flow from a departing high and the cool southerlies from the next in line bring a characteristic feature of Australian weather known as the "cool change". It is associated with the trough between two travelling anticyclones, but only occasionally has an associated front with marked cloudiness and showers. The cool change may be accompanied by strong gusty winds. It most resembles a dry summer cold front in North America, except that being more regular it is predictable in a general sort of way a few days ahead of time.

Tropical cyclones or hurricanes are also an occasional visitor to Australia in the summer months, but for the most part remain well to the north of the eclipse track. About ten percent are caught in the counterclockwise flow around a high pressure cell and steered southward, some as far as the south coast and the Great Australian Bight. Nearly all will have lost their hurricane intensity before they reach the latitude of the eclipse track, though a few exceptional ones have managed to cross into southern waters with their winds intact.

Sunshine charts for Australia show that the south in general and the southwest in particular have the best chances of clear skies for the eclipse (Figure 2). This advantage is tempered by the low sun angle at eclipse time, which will make any clouds which build along the horizon to appear thicker than their actual projection on the Earth. The clearest skies will most likely be found east of Perth, where the centre line near Narrogin can be recommended. In Tasmania the best prospects are to be had on the eastern side, likely near Launceston. Sunshine hours in this area are nearly as great as those near Perth, and the sun is at a more observable 35° altitude.

NEW ZEALAND

New Zealand weather patterns are more variable than those in Australia as a result of its position in the mid-latitude westerly winds. As in much of North America, its weather is due to the regular oscillation of low and high pressure systems, with alternating cloudy and sunny skies. The migratory nature of the lows favours short periods of rain followed by longer periods of relatively clear weather. Because of its mountainous landscape, the New Zealand climate is subject to many more local influences than Australia.

Prevailing westerlies are diverted to the northeast on the windward coast, and then flow around the mountain barrier to become southeasterlies on the leeward side. If the westerlies are strong, considerable rain may fall on the windy side, as seen in the monthly precipitation figure for Hokitika (Table 1). In contrast, the sheltered side experiences a strong downslope foehn (chinook) wind, and rainfall and cloud cover are greatly reduced (Christchurch, Table 1). Because the terrain generally rises less steeply on the east coast, orographic lifting of onshore winds is weaker and cloudiness is correspondingly reduced.

The average wind flow is often disturbed by sea breezes, though not as strongly as in Australia. Tasman Bay is especially subject to such winds, which may carry inland as far as thirty kilometres. Some light cloudiness may accompany the start of the sea breeze, but will be carried inland as the winds continue.

Despite its landfall at the ominously named Cape Foulwind, the portion of the eclipse track across the South Island offers the best prospects for clear weather (Figure 3). Northwesterly winds are particularly favoured in this area of the shadow path, as nearby Cook Strait is aligned on this axis and allows an unimpeded flow through the gap between the islands. This is a prominent reason for the capital's popular name of "Windy Wellington". Nelson and Blenheim, the sunniest locations in the country, are nestled in branches of the Southern Alps and are protected from both northwesterly and southwesterly flows. This is the most promising area from which to view the eclipse.

Tropical cyclones are also an occasional unwelcome visitor in the summer, though averaging only one per month in January. They tend to affect the north and east parts of the North Island, but may occasionally roam as far south as the eclipse track.

FRENCH POLYNESIA

Heading northeastward after leaving New Zealand, the eclipse path recrosses the belt of anticyclones and moves into the southern hemisphere trade winds. Only a few tiny Pacific islands south of Tahiti provide a last land-based opportunity for a view of the solar ring. Cloud cover in the area is variable, with convective buildups growing and dying on an hourly basis. Larger islands promote the development of these buildups by providing a warm land surface and occasional hills or mountains to enhance the air's ascent, but sunshine is generous in such tropical climates. In general the cloud cover is similar to that in New Zealand, though sunny skies should be easier to find because of the general lack of large organized weather systems.

Table 1

Location	Average Daily High (C)	Average Daily Low (C)	Mean Monthly Rainfall (mm)	Days with Rain	Mean Cloud Cover (eighths)	Mean hours of Sunshine
Australia						
Merridin	34	17	8	2	2.0	343
Perth	29	17	7	3	2.3	312
Esperance	25	15	20	5	3.5	—
Albany	23	15	35	9	4.8	217
Kalgoorlie	35	18	24	3	2.0	—
Launceston	24	11	41	8	4.2	—
Hobart	21	11	46	13	5.1	—
Maatsuyker Is.	16	10	77	19	6.2	—
Stanley	20	12	43	5	—	—
New Zealand						
Napier	24	14	66	8	4.0	250
Nelson	22	12	69	9	4.6	260
Wellington	20	13	74	10	5.6	234
Hokitika	19	11	249	14	5.6	208
Lake Tekapo	22	9	53	7	3.8	258
Christchurch	21	12	56	10	5.1	215
French Polynesia						
Papeete	32	22	251	16	—	—

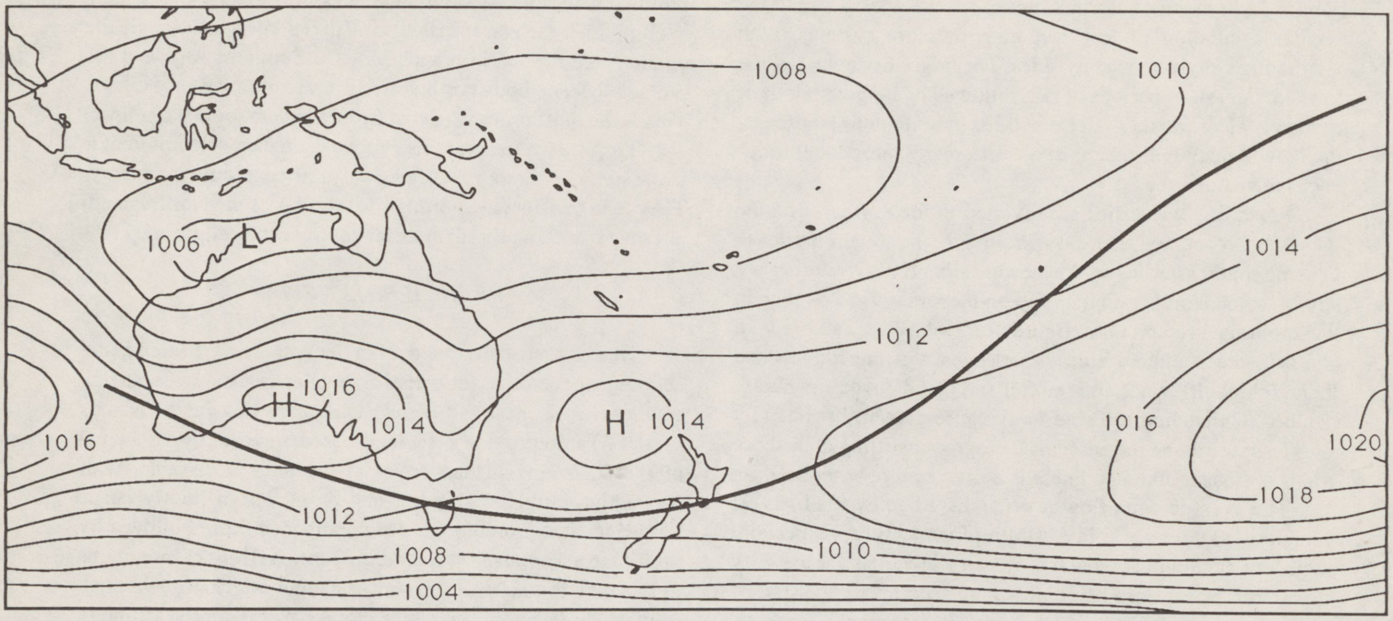

1008
1010
1006
L
1014
1012
1016
H
1016
1014
H
1014
1016
1020
1016
1018
1012
1010
1008
1004

Figure 1: Mean surface pressures for January along the eclipse track. Pressure contours are in millibars.

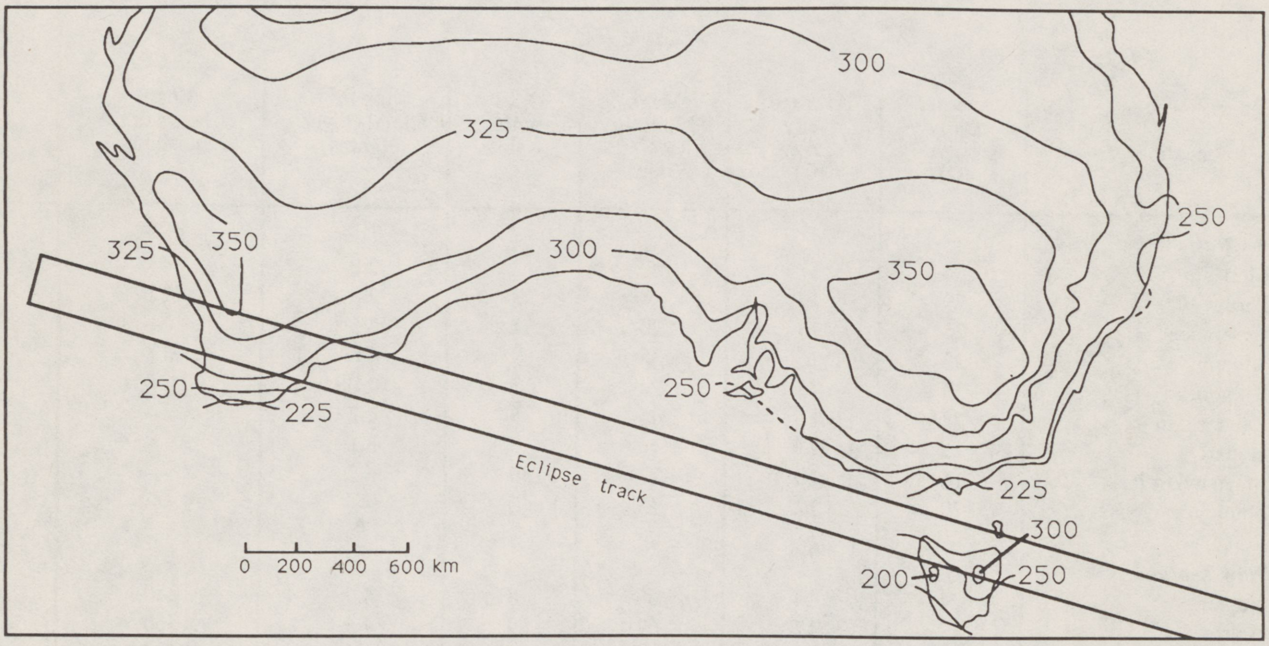

300
325
250
325
350
300
350
250
225
250
225
Eclipse track
300
200
250
0 200 400 600 km

Figure 2: Mean hours of sunshine in January over southern Australia. For comparative purposes, Sacramento has 437 hours of sunshine in July, San Francisco, 295, Chicago, 310, Atlanta, 277 and New York, 307.

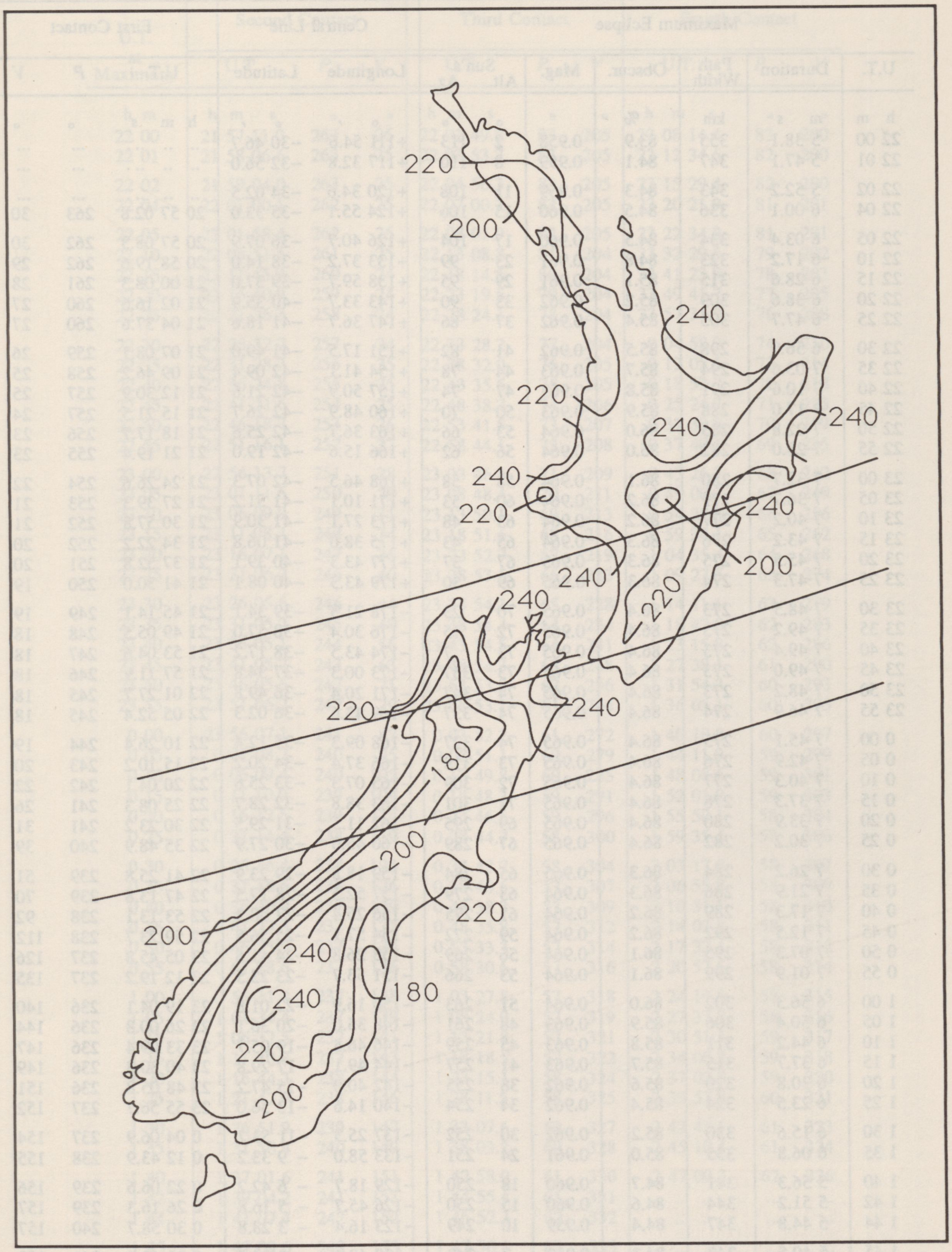

220
200
240
220
240
240
240
220
240
200
240
240
220
220
240
180
200
220
200
240
180
240
220
200

Figure 3: Mean hours of sunshine in January over New Zealand. For comparative purposes, Vancouver has 294 hours of sunshine in July, Winnipeg, 312, Toronto, 287, Topeka, 299 and Albuquerque, 329.

LOCAL CIRCUMSTANCES FOR POINTS ON THE CENTRAL LINE

Maximum Eclipse							Central Line		First Contact		
U.T.	Duration	Path Width	Obscur.	Mag.	Sun's Alt.	Az.	Longitude	Latitude	U.T.	*P*	*V*
h m	m s	km	%		°	°	° ′	° ′	h m s	°	°
22 00	5 38.1	355	83.9	0.958	2	113	+111 54.6	−30 46.7	.. ..	...	...
22 01	5 47.1	347	84.1	0.959	8	110	+117 32.8	−32 56.0	.. ..	...	...
22 02	5 52.2	343	84.3	0.959	11	108	+120 34.6	−34 02.5	.. ..	...	...
22 04	6 00.1	336	84.5	0.960	15	106	+124 55.1	−35 33.0	20 57 02.8	263	30
22 05	6 03.4	334	84.5	0.960	17	104	+126 40.7	−36 07.9	20 57 08.3	262	30
22 10	6 17.2	323	84.8	0.961	23	99	+133 37.2	−38 14.0	20 58 19.6	262	29
22 15	6 28.6	315	85.1	0.961	29	95	+138 59.7	−39 37.0	21 00 08.3	261	28
22 20	6 38.6	309	85.2	0.962	33	90	+143 33.7	−40 35.9	21 02 16.6	260	27
22 25	6 47.7	303	85.4	0.962	37	86	+147 36.7	−41 18.6	21 04 37.6	260	27
22 30	6 56.0	298	85.5	0.962	41	82	+151 17.5	−41 49.0	21 07 08.1	259	26
22 35	7 03.6	294	85.7	0.963	44	78	+154 41.1	−42 09.4	21 09 46.2	258	25
22 40	7 10.6	291	85.8	0.963	47	74	+157 50.9	−42 21.6	21 12 30.9	257	25
22 45	7 17.0	288	85.9	0.963	50	70	+160 48.9	−42 26.7	21 15 21.5	257	24
22 50	7 22.8	285	86.0	0.964	53	66	+163 36.7	−42 25.6	21 18 17.7	256	23
22 55	7 28.0	282	86.0	0.964	56	62	+166 15.6	−42 19.0	21 21 19.4	255	23
23 00	7 32.7	280	86.1	0.964	58	58	+168 46.5	−42 07.3	21 24 26.6	254	22
23 05	7 36.7	279	86.2	0.964	60	53	+171 10.1	−41 51.2	21 27 39.3	253	21
23 10	7 40.2	277	86.2	0.964	63	48	+173 27.1	−41 30.9	21 30 57.8	252	21
23 15	7 43.2	276	86.3	0.964	65	43	+175 38.0	−41 06.8	21 34 22.2	252	20
23 20	7 45.5	275	86.3	0.965	67	37	+177 43.3	−40 39.1	21 37 52.8	251	20
23 25	7 47.3	274	86.3	0.965	69	30	+179 43.3	−40 08.1	21 41 30.0	250	19
23 30	7 48.5	273	86.4	0.965	70	23	−178 21.3	−39 34.1	21 45 14.1	249	19
23 35	7 49.2	273	86.4	0.965	72	15	−176 30.4	−38 57.0	21 49 05.5	248	18
23 40	7 49.4	273	86.4	0.965	73	7	−174 43.5	−38 17.2	21 53 04.6	247	18
23 45	7 49.0	273	86.4	0.965	73	357	−173 00.3	−37 34.8	21 57 11.9	246	18
23 50	7 48.2	273	86.4	0.965	74	347	−171 20.4	−36 49.8	22 01 27.7	245	18
23 55	7 46.9	274	86.4	0.965	74	337	−169 43.6	−36 02.3	22 05 52.4	245	18
0 00	7 45.1	275	86.4	0.965	74	327	−168 09.3	−35 12.4	22 10 26.4	244	19
0 05	7 42.9	276	86.4	0.965	73	318	−166 37.4	−34 20.2	22 15 10.2	243	20
0 10	7 40.3	277	86.4	0.965	72	309	−165 07.3	−33 25.6	22 20 04.1	242	22
0 15	7 37.3	278	86.4	0.965	71	301	−163 38.8	−32 28.7	22 25 08.3	241	26
0 20	7 33.9	280	86.4	0.965	69	295	−162 11.5	−31 29.5	22 30 23.2	241	31
0 25	7 30.2	282	86.4	0.965	67	289	−160 45.0	−30 27.9	22 35 48.9	240	39
0 30	7 26.2	284	86.3	0.965	65	284	−159 18.8	−29 23.9	22 41 25.8	239	51
0 35	7 21.9	286	86.3	0.964	63	279	−157 52.5	−28 17.5	22 47 13.8	239	70
0 40	7 17.3	289	86.2	0.964	61	275	−156 25.4	−27 08.3	22 53 13.1	238	92
0 45	7 12.5	292	86.2	0.964	59	272	−154 57.1	−25 56.5	22 59 23.7	238	112
0 50	7 07.3	295	86.1	0.964	56	269	−153 26.8	−24 41.6	23 05 45.8	237	126
0 55	7 01.9	299	86.1	0.964	53	266	−151 53.7	−23 23.5	23 12 19.2	237	135
1 00	6 56.3	302	86.0	0.964	51	263	−150 16.9	−22 01.8	23 19 04.1	236	140
1 05	6 50.4	306	85.9	0.963	48	261	−148 35.0	−20 36.1	23 26 00.8	236	144
1 10	6 44.2	311	85.8	0.963	45	259	−146 46.4	−19 05.7	23 33 09.4	236	147
1 15	6 37.7	315	85.7	0.963	41	257	−144 49.1	−17 29.8	23 40 30.8	236	149
1 20	6 30.8	320	85.6	0.962	38	255	−142 40.0	−15 47.2	23 48 05.8	236	151
1 25	6 23.5	324	85.4	0.962	34	254	−140 14.6	−13 56.0	23 55 56.7	237	152
1 30	6 15.6	330	85.2	0.962	30	252	−137 25.3	−11 53.2	0 04 06.9	237	154
1 35	6 06.8	335	85.0	0.961	24	251	−133 58.0	− 9 33.2	0 12 43.9	238	155
1 40	5 56.3	341	84.7	0.960	18	250	−129 18.7	− 6 42.2	0 22 06.6	239	156
1 42	5 51.2	344	84.6	0.960	15	250	−126 45.7	− 5 16.8	0 26 16.3	239	157
1 44	5 44.8	347	84.4	0.959	10	249	−123 16.4	− 3 28.8	0 30 58.7	240	157
1 45	5 40.5	349	84.3	0.959	7	249	−120 40.3	− 2 14.5	0 33 49.4	241	158

LOCAL CIRCUMSTANCES FOR POINTS ON THE CENTRAL LINE

U.T. at Maximum	Second Contact			Third Contact			Fourth Contact		
	U.T.	*P*	*V*	U.T.	*P*	*V*	U.T.	*P*	*V*
h m	h m s	°	°	h m s	°	°	h m s	°	°
22 00	21 57 11.0	263	26	22 02 49.2	83	205	23 08 14.4	83	200
22 01	21 58 06.6	263	25	22 03 53.7	83	205	23 12 34.6	82	200
22 02	21 59 04.0	263	25	22 04 56.3	83	205	23 15 29.4	82	200
22 04	22 01 00.1	262	25	22 07 00.2	82	205	23 20 21.9	81	201
22 05	22 01 58.4	262	25	22 08 01.9	82	205	23 22 34.2	81	201
22 10	22 06 51.5	261	25	22 13 08.8	81	204	23 32 29.5	79	202
22 15	22 11 45.9	260	24	22 18 14.5	80	204	23 41 23.9	78	203
22 20	22 16 40.9	259	24	22 23 19.5	79	204	23 49 41.7	77	205
22 25	22 21 36.3	258	24	22 28 24.1	78	204	23 57 31.9	76	208
22 30	22 26 32.2	257	24	22 33 28.2	77	204	0 04 58.9	74	210
22 35	22 31 28.3	256	25	22 38 32.0	76	205	0 12 05.6	73	214
22 40	22 36 24.8	255	25	22 43 35.5	75	205	0 18 53.7	72	218
22 45	22 41 21.6	254	25	22 48 38.7	74	206	0 25 24.7	71	223
22 50	22 46 18.7	253	26	22 53 41.5	73	207	0 31 39.8	70	229
22 55	22 51 16.1	252	27	22 58 44.1	72	208	0 37 40.1	69	235
23 00	22 56 13.7	251	28	23 03 46.4	71	209	0 43 26.7	68	242
23 05	23 01 11.6	250	29	23 08 48.4	70	211	0 49 00.7	67	249
23 10	23 06 09.9	249	31	23 13 50.1	69	213	0 54 22.8	66	256
23 15	23 11 08.4	248	34	23 18 51.6	68	216	0 59 34.1	65	262
23 20	23 16 07.1	247	36	23 23 52.7	67	219	1 04 35.4	64	268
23 25	23 21 06.2	246	40	23 28 53.5	66	223	1 09 27.5	63	274
23 30	23 26 05.6	246	44	23 33 54.1	65	228	1 14 11.1	63	279
23 35	23 31 05.2	245	49	23 38 54.4	64	234	1 18 47.0	62	283
23 40	23 36 05.1	244	56	23 43 54.5	64	241	1 23 15.8	62	286
23 45	23 41 05.2	243	63	23 48 54.3	63	248	1 27 38.1	61	290
23 50	23 46 05.6	242	71	23 53 53.8	62	256	1 31 54.3	60	293
23 55	23 51 06.2	242	79	23 58 53.1	61	264	1 36 05.1	60	295
0 00	23 56 07.1	241	87	0 03 52.2	61	272	1 40 10.8	60	297
0 05	0 01 08.2	240	95	0 08 51.1	60	279	1 44 11.9	59	299
0 10	0 06 09.4	240	102	0 13 49.8	60	285	1 48 08.6	59	301
0 15	0 11 10.9	239	109	0 18 48.3	59	291	1 52 01.2	59	303
0 20	0 16 12.6	239	114	0 23 46.6	59	296	1 55 50.1	58	304
0 25	0 21 14.4	238	119	0 28 44.7	58	300	1 59 35.4	58	306
0 30	0 26 16.4	238	123	0 33 42.7	58	304	2 03 17.2	58	307
0 35	0 31 18.6	238	126	0 38 40.6	57	307	2 06 55.8	58	309
0 40	0 36 20.9	237	129	0 43 38.3	57	309	2 10 31.1	58	310
0 45	0 41 23.3	237	132	0 48 35.8	57	312	2 14 03.2	58	311
0 50	0 46 25.9	237	134	0 53 33.3	57	314	2 17 32.1	58	312
0 55	0 51 28.6	237	136	0 58 30.6	57	316	2 20 57.6	58	314
1 00	0 56 31.4	237	138	1 03 27.8	57	318	2 24 19.6	58	315
1 05	1 01 34.4	237	139	1 08 24.9	57	319	2 27 37.7	58	316
1 10	1 06 37.5	237	141	1 13 21.8	57	321	2 30 51.5	59	317
1 15	1 11 40.8	237	143	1 18 18.5	57	322	2 34 00.2	59	318
1 20	1 16 44.3	238	144	1 23 15.1	58	324	2 37 02.9	59	320
1 25	1 21 47.9	238	146	1 28 11.5	58	325	2 39 57.8	60	321
1 30	1 26 51.9	239	147	1 33 07.6	59	327	2 42 42.1	61	323
1 35	1 31 56.4	240	149	1 38 03.2	60	328	2 45 10.4	61	324
1 40	1 37 01.6	241	151	1 42 58.0	61	330	2 47 09.3	62	326
1 42	1 39 04.2	241	151	1 44 55.4	61	331	.. ..	...	...
1 44	1 41 07.4	242	152	1 46 52.3	62	332	.. ..	...	...
1 45	1 42 09.6	243	153	1 47 50.1	63	333	.. ..	...	...

LOCAL CIRCUMSTANCES FOR GEOGRAPHIC LOCATIONS

Position		Name of Location	Duration of Annularity	Maximum Eclipse					
Latitude	Longitude			Path Width	U.T.	Obscur.	Mag.	Sun's Alt.	Az.
° ′	° ′	***Australia (Mainland)***	m s	km	h m s	%		°	°
−34 56.0	+138 36.0	Adelaide			22 09 46.3	76.9	0.840	27	98
−35 01.0	+117 54.0	Albany			22 02 55.3	83.8	0.907	9	109
−23 42.0	+133 52.0	Alice Springs			21 56 56.3	46.3	0.575	18	106
−32 08.0	+116 01.0	Armadale	5 41.6	349	22 00 25.2	84.1	0.953	6	111
−32 00.5	+116 08.1	Bickley (Perth Obs.)	5 35.6	348	22 00 17.6	84.1	0.949	6	111
−33 55.5	+116 08.5	Bridgetown	2 44.8	351	22 02 00.5	84.1	0.922	7	111
−27 30.0	+153 00.0	Brisbane			22 21 59.1	43.6	0.550	41	95
−31 57.0	+141 30.0	Broken Hill			22 09 25.7	65.2	0.740	29	98
−33 20.0	+115 38.0	Bunbury	4 22.5	351	22 01 31.3	84.1	0.932	6	111
−24 50.0	+152 21.0	Bundaberg			22 19 19.6	35.5	0.475	39	98
−33 39.0	+115 20.5	Busselton	2 35.9	353	22 01 50.5	84.1	0.921	6	111
−16 51.0	+145 43.0	Cairns			22 04 25.0	17.3	0.288	28	105
−35 18.0	+149 08.0	Canberra			22 21 18.8	71.1	0.789	38	91
−33 21.0	+116 09.0	Collie	4 49.2	350	22 01 29.0	84.1	0.936	7	111
−32 20.0	+117 51.0	Corrigin	5 15.8	346	22 00 26.7	84.1	0.941	8	110
−12 23.0	+130 44.0	Darwin			21 49 49.9	18.1	0.297	10	110
−33 51.5	+121 52.0	Esperance	5 27.3	340	22 01 54.3	84.3	0.943	12	108
−32 11.0	+126 15.0	Eyre			22 01 00.1	79.4	0.863	14	106
−32 07.0	+115 44.0	Fremantle	5 43.0	349	22 00 26.3	84.0	0.955	6	111
−38 10.0	+144 26.0	Geelong			22 18 21.2	82.6	0.891	33	92
−28 49.0	+114 36.0	Geraldton			21 57 54.9	81.4	0.883	3	112
−35 22.3	+149 25.4	Hoskinstown (Molongo Radio Obs.)			22 21 45.7	71.2	0.790	38	90
−30 49.0	+121 29.0	Kalgoorlie			21 59 06.3	80.2	0.871	10	109
−33 41.0	+117 32.0	Katanning	5 11.6	348	22 01 41.0	84.1	0.940	8	110
−33 51.8	+150 46.5	Kemps Creek (Fleurs Radio Obs.)			22 22 30.1	65.5	0.741	39	91
−33 50.0	+117 09.5	Kojonup	4 35.0	349	22 01 50.6	84.1	0.933	8	110
−33 49.8	+151 09.5	Lane Cove (Riverview Coll. Obs.)			22 23 03.7	65.2	0.739	40	90
−32 14.0	+115 48.0	Medina	5 44.1	349	22 00 31.9	84.0	0.957	6	111
−37 45.0	+144 58.0	Melbourne			22 18 30.1	81.2	0.877	34	92
−31 29.0	+118 18.0	Merredin			21 59 40.6	84.1	0.916	7	110
−34 37.0	+117 40.0	Mount Barker	1 42.6	349	22 02 32.9	84.2	0.919	9	110
−35 19.2	+149 00.5	Mt. Stromlo (Mt. Stromlo Obs.)			22 21 08.7	71.3	0.790	38	91
−30 18.9	+149 33.7	Narrabri (Culgoora Solar Obs.)			22 17 57.3	54.4	0.646	37	95
−32 57.0	+117 10.5	Narrogin	5 45.0	348	22 01 02.3	84.1	0.955	7	110
−32 55.0	+151 46.0	Newcastle			22 23 20.2	61.9	0.710	40	91
−31 39.0	+116 40.0	Northam	4 47.1	347	21 59 56.2	84.1	0.935	6	111
−33 00.0	+148 15.7	Parkes (National Radio Ast. Obs.)			22 18 10.4	64.0	0.729	36	93
−31 58.0	+115 49.0	Perth	5 38.3	349	22 00 17.9	84.0	0.951	6	111
−32 37.0	+115 52.0	Pinjarra	5 38.6	350	22 00 51.6	84.1	0.951	6	111
−33 11.0	+138 01.0	Port Pirie			22 07 36.4	71.9	0.797	26	99
−23 22.0	+150 32.0	Rockhampton			22 15 12.4	32.1	0.442	37	100
−32 16.0	+115 43.0	Rockingham	5 44.0	350	22 00 34.2	84.0	0.958	6	111
−31 16.5	+149 04.2	Siding Spring Mtn. (Royal Obs.)			22 17 55.5	57.9	0.676	37	94
−33 55.0	+151 10.0	Sydney			22 23 08.5	65.5	0.741	40	90
−19 13.0	+146 48.0	Townsville			22 07 00.5	22.7	0.347	30	104
−33 18.0	+117 21.0	Wagin	5 35.1	348	22 01 20.6	84.1	0.948	8	110
−32 47.0	+117 30.0	Wickepin	5 45.9	347	22 00 52.0	84.1	0.955	8	110
−34 25.0	+150 52.0	Wollongong			22 23 04.6	67.3	0.757	40	90
−31 53.0	+116 45.0	York	5 10.7	347	22 00 07.8	84.1	0.940	6	111
		Australia (Tasmania)							
−41 14.0	+146 24.0	Atrobe	6 43.3	305	22 23 34.1	85.4	0.959	36	87
−41 12.0	+146 49.0	Beaconsfield	6 45.9	304	22 23 59.5	85.4	0.962	36	87
−41 03.0	+145 55.0	Burnie	6 43.8	306	22 22 51.6	85.3	0.961	35	88
−41 10.0	+146 21.0	Devonport	6 44.4	305	22 23 26.8	85.4	0.960	36	88
−41 38.0	+147 59.0	Fingal	6 40.6	303	22 25 44.8	85.4	0.955	38	86
−43 11.0	+147 53.0	Geeveston			22 27 11.8	84.7	0.910	38	84
−42 50.0	+147 32.0	Hobart (Univ. of Tasmania Obs.)			22 26 26.7	85.3	0.918	37	85
−41 25.0	+147 07.0	Launceston	6 42.8	304	22 24 32.7	85.4	0.957	37	87
−42 18.5	+147 22.0	Oatlands	4 32.5	305	22 25 43.8	85.4	0.934	37	86
−42 05.0	+145 33.0	Queenstown	4 07.8	308	22 23 33.2	85.3	0.932	35	87
−41 33.0	+148 12.0	St. Mary's	6 46.4	303	22 25 54.9	85.4	0.958	38	86
−41 09.0	+147 31.0	Scotsdale	6 45.5	303	22 24 43.7	85.4	0.958	37	87
−40 51.0	+145 07.0	Smithton	6 42.0	307	22 21 48.8	85.3	0.961	35	89
−41 02.0	+145 50.0	Somerset	6 43.7	306	22 22 45.2	85.3	0.961	35	88
−40 59.0	+145 43.0	Wynyard	6 43.4	306	22 22 34.7	85.3	0.961	35	88
−41 53.0	+145 20.0	Zeehan	4 57.2	308	22 23 07.2	85.3	0.936	35	88

Assumed to be sea level, except observatories.

Names and spelling are not authoritative, nor do they imply any official recognition of status.

No correction for elevation, limb or refraction included.

LOCAL CIRCUMSTANCES FOR GEOGRAPHIC LOCATIONS

Position		First Contact			Second Contact			Third Contact			Fourth Contact		
Latitude	Longitude	U.T.	*P*	*V*	U.T.	*P*	*V*	U.T.	*P*	*V*	U.T.	*P*	*V*
° ′	° ′	h m s	°	°	h m s	°	°	h m s	°	°	h m s	°	°
−34 56.0	+138 36.0	20 55 43.9	254	17							23 36 19.2	86	205
−35 01.0	+117 54.0	.. ..	...	...							23 14 44.4	79	199
−23 42.0	+133 52.0	20 51 30.5	240	354							23 13 34.5	105	210
−32 08.0	+116 01.0	.. ..	...	...	21 57 34.5	255	18	22 03 16.1	91	212	23 11 02.6	83	200
−32 00.5	+116 08.1	.. ..	...	...	21 57 29.9	250	12	22 03 05.5	96	218	23 10 58.3	83	200
−33 55.5	+116 08.5	.. ..	...	...	22 00 37.8	324	88	22 03 22.6	21	145	23 12 46.7	80	199
−27 30.0	+153 00.0	21 02 11.3	235	346							23 57 41.0	100	209
−31 57.0	+141 30.0	20 54 42.7	248	8							23 37 41.7	92	206
−33 20.0	+115 38.0	.. ..	...	...	21 59 20.0	303	66	22 03 42.6	43	166	23 11 59.2	81	200
−24 50.0	+152 21.0	21 02 58.1	230	339							23 51 08.8	106	209
−33 39.0	+115 20.5	.. ..	...	...	22 00 32.3	326	89	22 03 08.2	20	143	23 12 08.3	80	199
−16 51.0	+145 43.0	21 05 03.0	218	321							23 14 09.7	124	217
−35 18.0	+149 08.0	21 00 07.7	250	11							23 56 53.2	86	209
−33 21.0	+116 09.0	.. ..	...	...	21 59 04.4	296	59	22 03 53.6	50	173	23 12 15.1	81	200
−32 20.0	+117 51.0	.. ..	...	...	21 57 48.9	238	0	22 03 04.7	108	229	23 12 09.1	83	201
−12 23.0	+130 44.0	.. ..	...	...							22 47 09.9	127	222
−33 51.5	+121 52.0	.. ..	...	...	21 59 10.7	240	2	22 04 38.1	105	227	23 16 12.3	83	201
−32 11.0	+126 15.0	20 54 03.9	257	21							23 17 55.5	87	203
−32 07.0	+115 44.0	.. ..	...	...	21 57 34.9	258	21	22 03 18.0	88	209	23 10 53.8	83	200
−38 10.0	+144 26.0	21 00 02.7	256	21							23 49 33.0	81	206
−28 49.0	+114 36.0	.. ..	...	...							23 07 14.9	87	202
−35 22.3	+149 25.4	21 00 20.2	250	11							23 57 35.3	86	209
−30 49.0	+121 29.0	.. ..	...	...							23 12 43.4	87	202
−33 41.0	+117 32.0	.. ..	...	...	21 59 05.2	289	52	22 04 16.8	57	179	23 13 17.0	81	200
−33 51.8	+150 46.5	21 00 29.4	247	6							23 59 27.3	88	209
−33 50.0	+117 09.5	.. ..	...	...	21 59 33.0	300	63	22 04 08.1	45	168	23 13 13.3	81	200
−33 49.8	+151 09.5	21 00 45.6	246	5							0 00 21.2	88	210
−32 14.0	+115 48.0	.. ..	...	...	21 57 40.0	262	24	22 03 24.1	84	206	23 11 02.3	83	200
−37 45.0	+144 58.0	20 59 52.1	255	20							23 50 14.0	82	206
−31 29.0	+118 18.0	.. ..	...	...							23 11 32.6	85	201
−34 37.0	+117 40.0	.. ..	...	...	22 01 41.3	335	99	22 03 24.0	10	133	23 14 14.0	80	199
−35 19.2	+149 00.5	21 00 02.9	250	11							23 56 36.7	86	208
−30 18.9	+149 33.7	20 58 40.9	241	357							23 52 35.4	95	208
−32 57.0	+117 10.5	.. ..	...	...	21 58 09.9	268	31	22 03 54.9	78	200	23 12 23.6	82	200
−32 55.0	+151 46.0	21 00 54.3	245	2							0 01 01.4	90	210
−31 39.0	+116 40.0	.. ..	...	...	21 57 32.6	229	351	22 02 19.8	117	238	23 10 53.0	84	201
−33 00.0	+148 15.7	20 58 25.7	247	5							23 52 42.7	90	208
−31 58.0	+115 49.0	.. ..	...	...	21 57 28.9	252	15	22 03 07.2	94	215	23 10 47.5	83	200
−32 37.0	+115 52.0	.. ..	...	...	21 58 02.4	273	36	22 03 41.0	72	195	23 11 25.8	82	200
−33 11.0	+138 01.0	20 54 26.5	252	14							23 33 23.2	89	205
−23 22.0	+150 32.0	21 02 07.1	228	336							23 43 02.1	109	210
−32 16.0	+115 43.0	.. ..	...	...	21 57 42.3	264	26	22 03 26.4	82	204	23 11 01.9	82	200
−31 16.5	+149 04.2	20 58 26.1	243	0							23 52 36.1	93	208
−33 55.0	+151 10.0	21 00 48.1	247	6							0 00 27.0	88	210
−19 13.0	+146 48.0	21 02 36.5	222	327							23 23 30.1	118	214
−33 18.0	+117 21.0	.. ..	...	...	21 58 33.1	278	40	22 04 08.3	68	190	23 12 49.2	82	200
−32 47.0	+117 30.0	.. ..	...	...	21 57 59.2	258	21	22 03 45.1	87	209	23 12 24.3	82	200
−34 25.0	+150 52.0	21 00 48.4	248	7							0 00 09.4	87	209
−31 53.0	+116 45.0	.. ..	...	...	21 57 32.5	237	359	22 02 43.2	109	230	23 11 09.0	84	201
−41 14.0	+146 24.0	21 04 00.9	260	27	22 20 12.6	263	29	22 26 56.0	73	200	23 55 12.1	76	207
−41 12.0	+146 49.0	21 04 09.0	260	27	22 20 36.7	259	25	22 27 22.6	77	204	23 55 58.0	76	207
−41 03.0	+145 55.0	21 03 36.6	260	27	22 19 29.8	259	25	22 26 13.7	78	204	23 54 12.5	76	207
−41 10.0	+146 21.0	21 03 55.0	260	27	22 20 04.7	261	27	22 26 49.2	76	202	23 55 04.5	76	207
−41 38.0	+147 59.0	21 05 10.2	260	27	22 22 24.6	269	36	22 29 05.3	67	194	23 58 22.7	75	208
−43 11.0	+147 53.0	21 07 02.2	262	31							23 58 45.4	72	208
−42 50.0	+147 32.0	21 06 25.8	262	31							23 57 59.3	73	207
−41 25.0	+147 07.0	21 04 31.7	260	27	22 21 11.5	266	32	22 27 54.3	70	197	23 56 38.1	75	207
−42 18.5	+147 22.0	21 05 42.3	261	29	22 23 27.4	306	73	22 27 59.9	30	158	23 57 29.2	74	207
−42 05.0	+145 33.0	21 04 42.2	262	30	22 21 29.1	310	77	22 25 36.9	26	153	23 54 03.9	74	206
−41 33.0	+148 12.0	21 05 10.5	260	27	22 22 31.9	264	31	22 29 18.3	72	198	23 58 45.7	75	208
−41 09.0	+147 31.0	21 04 23.9	259	26	22 21 21.1	252	18	22 28 06.7	84	210	23 57 16.4	76	208
−40 51.0	+145 07.0	21 03 04.8	260	27	22 18 27.9	257	23	22 25 10.0	80	206	23 52 37.7	76	206
−41 02.0	+145 50.0	21 03 33.5	260	27	22 19 23.6	259	25	22 26 07.3	78	204	23 54 02.7	76	206
−40 59.0	+145 43.0	21 03 27.4	260	27	22 19 13.2	258	24	22 25 56.6	79	205	23 53 48.2	76	206
−41 53.0	+145 20.0	21 04 22.8	261	29	22 20 38.5	301	67	22 25 35.7	36	163	23 53 34.7	75	206

Dot leaders indicate the phenomenon occurs below the horizon. Blanks indicate the phenomenon does not occur for the location.

LOCAL CIRCUMSTANCES FOR GEOGRAPHIC LOCATIONS

Position		Name of Location	Duration of Annularity	Maximum Eclipse					
Latitude	Longitude			Path Width	U.T.	Obscur.	Mag.	Sun's Alt.	Sun's Az.
° ′	° ′	***New Zealand***	m s	km	h m s	%		°	°
−43 54.0	+171 46.0	Ashburton			23 05 57.6	84.3	0.904	60	49
−36 54.4	+174 46.7	Auckland (Auckland Obs.)			23 15 20.5	77.5	0.842	67	51
−41 44.9	+173 48.2	Black Birch (USNO; Carter Obs.)	7 27.1	277	23 10 40.3	86.2	0.956	63	47
−41 32.0	+173 58.0	Blenheim	7 39.0	277	23 11 07.2	86.2	0.961	63	47
−41 01.0	+175 32.0	Carterton	7 41.6	276	23 14 49.3	86.3	0.961	65	43
−43 33.0	+172 40.0	Christchurch			23 07 49.3	84.9	0.910	61	47
−40 12.0	+176 08.0	Dannevirke	6 02.3	274	23 16 38.0	86.3	0.942	66	42
−41 17.0	+174 54.0	Days Bay	7 42.0	276	23 13 16.8	86.2	0.964	64	45
−45 52.0	+170 30.0	Dunedin			23 03 27.4	78.8	0.854	57	49
−40 13.0	+175 34.0	Feilding	5 28.3	274	23 15 18.8	86.3	0.939	66	44
−40 28.0	+175 18.0	Foxton	6 26.7	275	23 14 34.2	86.3	0.945	65	44
−38 41.0	+178 02.0	Gisborne			23 22 11.7	85.2	0.912	69	38
−42 28.0	+171 12.0	Greymouth	6 37.6	280	23 04 58.8	86.2	0.947	60	52
−37 46.0	+175 18.0	Hamilton			23 16 06.8	80.6	0.869	67	48
−39 39.0	+176 52.0	Hastings	2 48.4	273	23 18 41.4	86.3	0.931	67	41
−39 41.0	+176 52.0	Havelock North	3 17.3	273	23 18 40.1	86.3	0.932	67	41
−42 42.0	+170 59.0	Hokitika	5 46.4	280	23 04 30.3	86.1	0.941	60	52
−46 26.0	+168 21.0	Invercargill			22 59 39.6	77.7	0.844	55	53
−42 24.0	+173 41.0	Kaikoura	5 16.7	278	23 10 13.1	86.2	0.938	62	46
−40 37.0	+175 18.0	Levin	6 57.6	275	23 14 29.7	86.3	0.949	65	44
−41 12.0	+174 54.0	Lower Hutt	7 42.0	276	23 13 19.1	86.2	0.963	64	45
−36 59.0	+174 53.0	Manukau			23 15 33.7	77.8	0.845	67	51
−40 04.0	+175 24.0	Marton	4 02.3	274	23 15 00.5	86.3	0.934	65	45
−40 57.0	+175 39.0	Masterton	7 40.2	276	23 15 07.1	86.3	0.960	65	43
−41 08.0	+173 01.0	Motueka	7 11.3	277	23 09 09.7	86.2	0.952	63	50
−43 59.2	+170 27.9	Mount John (Mt. John Univ. Obs.)			23 03 22.3	84.5	0.905	59	52
−39 31.0	+176 54.0	Napier			23 18 51.5	86.3	0.927	67	41
−41 18.0	+173 17.0	Nelson	7 32.5	277	23 09 41.9	86.2	0.957	63	49
−45 07.0	+170 58.0	Oamaru			23 04 19.4	81.0	0.873	58	49
−40 45.0	+175 09.0	Otaki	7 13.5	275	23 14 05.3	86.3	0.952	65	44
−40 27.0	+175 51.0	Pahiatua	6 48.1	275	23 15 50.3	86.3	0.947	66	43
−40 20.0	+175 39.0	Palmerston North	6 10.9	275	23 15 26.6	86.3	0.943	65	44
−41 17.0	+174 02.0	Picton	7 39.1	276	23 11 21.5	86.2	0.961	63	47
−41 08.0	+174 50.0	Porirua	7 40.0	276	23 13 11.9	86.2	0.961	64	45
−43 18.0	+172 35.5	Rangiora			23 07 43.0	85.5	0.916	61	48
−41 20.0	+173 12.0	Richmond	7 33.6	277	23 09 30.2	86.2	0.958	63	49
−38 07.0	+176 17.0	Rotorua			23 18 19.6	82.4	0.885	68	45
−44 23.0	+171 14.0	Timaru			23 04 52.0	83.2	0.893	59	50
−41 07.5	+175 03.0	Upper Hutt	7 41.3	276	23 13 41.2	86.3	0.961	64	44
−39 57.0	+176 35.0	Waipawa	5 10.0	274	23 17 49.8	86.3	0.938	67	41
−40 00.0	+176 33.0	Waipukurau	5 26.7	274	23 17 43.3	86.3	0.939	66	41
−39 56.0	+175 02.0	Wanganui			23 14 13.6	86.3	0.927	65	46
−41 17.2	+174 46.0	Wellington (Carter Obs.)	7 42.0	276	23 12 58.9	86.2	0.964	64	45
−41 46.0	+171 35.5	Westport	7 37.4	278	23 05 54.7	86.2	0.963	61	52
		Other							
− 9 28.0	+159 57.0	Honiara, Solomon Islands			22 39 55.1	0.1	0.006	48	111
−22 27.0	−151 20.0	Moerai, Rurutu	6 45.9	300	0 57 45.2	86.0	0.954	52	264
−22 16.0	+166 26.0	Noumea, New Caledonia			22 58 14.1	25.9	0.380	61	94
−14 16.0	−170 43.0	Pago Pago, American Samoa			0 39 14.2	31.5	0.436	73	244
−17 32.0	−149 34.0	Papeete, Tahiti			1 09 58.9	82.3	0.886	47	258
− 9 30.0	+147 07.0	Port Moresby, Papua New Guinea			22 05 02.3	2.2	0.070	28	109
−18 08.0	+178 25.0	Suva, Fiji			23 53 21.8	23.7	0.357	84	120
−17 20.0	−145 30.5	Tukuhora, Anaa	6 08.1	313	1 14 39.2	85.7	0.948	42	257
−16 30.0	−152 15.0	Vaitape, Bora Bora			1 08 47.2	74.7	0.818	50	257

Assumed to be sea level, except observatories.

Names and spelling are not authoritative, nor do they imply any official recognition of status.

No correction for elevation, limb or refraction included.

LOCAL CIRCUMSTANCES FOR GEOGRAPHIC LOCATIONS

Position		First Contact			Second Contact			Third Contact			Fourth Contact		
Latitude	Longitude	U.T.	*P*	*V*	U.T.	*P*	*V*	U.T.	*P*	*V*	U.T.	*P*	*V*
° ′	° ′	h m s	°	°	h m s	°	°	h m s	°	°	h m s	°	°
−43 54.0	+171 46.0	21 30 05.4	257	28							0 47 40.3	63	246
−36 54.4	+174 46.7	21 31 58.1	244	6							1 03 29.4	72	274
−41 44.9	+173 48.2	21 31 37.9	253	22	23 06 56.7	262	45	23 14 23.9	56	201	0 54 48.0	65	256
−41 32.0	+173 58.0	21 31 47.9	252	21	23 07 17.6	254	37	23 14 56.6	64	209	0 55 27.0	66	257
−41 01.0	+175 32.0	21 34 09.3	251	20	23 10 58.5	243	28	23 18 40.1	73	221	0 59 30.2	65	262
−43 33.0	+172 40.0	21 31 07.4	256	27							0 49 57.5	63	249
−40 12.0	+176 08.0	21 34 53.6	250	17	23 13 36.7	209	354	23 19 39.1	107	254	1 01 59.9	66	267
−41 17.0	+174 54.0	21 33 12.4	252	20	23 09 25.8	250	34	23 17 07.8	67	214	0 57 46.7	65	260
−45 52.0	+170 30.0	21 30 14.4	260	34							0 42 36.5	61	239
−40 13.0	+175 34.0	21 33 54.3	250	17	23 12 34.5	203	347	23 18 02.9	113	259	1 00 45.6	66	265
−40 28.0	+175 18.0	21 33 32.0	251	18	23 11 20.8	214	358	23 17 47.5	102	248	0 59 49.2	66	264
−38 41.0	+178 02.0	21 38 05.5	247	13							1 08 24.7	67	276
−42 28.0	+171 12.0	21 28 07.8	254	23	23 01 39.9	279	59	23 08 17.6	41	183	0 48 19.8	66	248
−37 46.0	+175 18.0	21 32 56.2	246	9							1 03 36.9	70	273
−39 39.0	+176 52.0	21 36 03.5	249	16	23 17 16.9	178	325	23 20 05.4	136	284	1 04 24.1	66	270
−39 41.0	+176 52.0	21 36 03.9	249	16	23 17 01.2	182	329	23 20 18.5	133	280	1 04 21.0	66	270
−42 42.0	+170 59.0	21 27 59.3	255	24	23 01 37.0	290	71	23 07 23.5	30	172	0 47 35.0	66	247
−46 26.0	+168 21.0	21 28 08.4	261	35							0 37 49.2	61	234
−42 24.0	+173 41.0	21 31 51.5	254	24	23 07 34.6	295	79	23 12 51.3	23	168	0 53 38.2	64	254
−40 37.0	+175 18.0	21 33 35.5	251	19	23 11 00.8	222	6	23 17 58.4	94	240	0 59 36.1	66	263
−41 12.0	+174 54.0	21 33 10.0	252	20	23 09 28.0	246	30	23 17 10.0	71	217	0 57 54.0	65	260
−36 59.0	+174 53.0	21 32 09.6	245	7							1 03 38.9	71	275
−40 04.0	+175 24.0	21 33 33.9	250	17	23 12 59.2	189	333	23 17 01.5	127	272	1 00 37.1	67	265
−40 57.0	+175 39.0	21 34 19.6	251	20	23 11 16.9	241	26	23 18 57.2	75	223	0 59 50.9	65	263
−41 08.0	+173 01.0	21 30 03.6	252	20	23 05 34.0	229	9	23 12 45.3	90	233	0 53 57.0	67	256
−43 59.2	+170 27.9	21 28 18.7	257	28							0 44 55.1	64	243
−39 31.0	+176 54.0	21 36 05.4	249	16							1 04 40.7	66	271
−41 18.0	+173 17.0	21 30 34.4	252	20	23 05 55.6	238	20	23 13 28.1	80	224	0 54 18.4	66	256
−45 07.0	+170 58.0	21 30 05.5	259	31							0 44 29.1	62	242
−40 45.0	+175 09.0	21 33 23.3	251	19	23 10 28.5	227	11	23 17 42.0	89	235	0 59 05.2	66	262
−40 27.0	+175 51.0	21 34 28.8	250	18	23 12 26.1	219	4	23 19 14.3	97	244	1 01 01.2	66	265
−40 20.0	+175 39.0	21 34 05.4	250	18	23 12 21.0	211	355	23 18 32.0	105	252	1 00 46.0	66	265
−41 17.0	+174 02.0	21 31 46.5	252	20	23 07 31.9	243	26	23 15 11.1	75	220	0 55 56.5	66	258
−41 08.0	+174 50.0	21 33 01.4	252	20	23 09 21.8	242	26	23 17 01.9	75	221	0 57 51.4	66	260
−43 18.0	+172 35.5	21 30 49.0	256	26							0 50 08.9	64	249
−41 20.0	+173 12.0	21 30 27.5	252	20	23 05 43.4	239	21	23 13 17.1	79	223	0 54 05.0	66	256
−38 07.0	+176 17.0	21 34 45.9	246	11							1 05 24.0	69	274
−44 23.0	+171 14.0	21 29 45.6	257	29							0 45 58.1	63	244
−41 07.5	+175 03.0	21 33 23.0	252	20	23 09 50.5	244	28	23 17 31.8	73	220	0 58 19.5	65	261
−39 57.0	+176 35.0	21 35 37.2	250	17	23 15 14.6	199	345	23 20 24.7	116	264	1 03 20.2	66	268
−40 00.0	+176 33.0	21 35 34.5	250	17	23 14 59.8	202	348	23 20 26.5	113	261	1 03 11.4	66	268
−39 56.0	+175 02.0	21 32 53.2	250	16							1 00 00.5	67	265
−41 17.2	+174 46.0	21 32 59.0	252	20	23 09 07.8	249	33	23 16 49.9	68	215	0 57 29.5	65	260
−41 46.0	+171 35.5	21 28 13.7	253	21	23 02 06.0	249	28	23 09 43.5	71	213	0 50 02.2	67	250
− 9 28.0	+159 57.0	22 25 55.0	172	255							22 53 42.9	158	237
−22 27.0	−151 20.0	23 15 41.9	236	138	0 54 21.8	222	122	1 01 07.8	72	332	2 23 01.6	59	315
−22 16.0	+166 26.0	21 29 46.8	218	319							0 38 35.6	103	205
−14 16.0	−170 43.0	22 55 19.1	205	258							2 07 14.6	88	2
−17 32.0	−149 34.0	23 30 51.5	231	148							2 32 18.3	63	324
− 9 30.0	+147 07.0	21 31 27.5	194	287							22 41 33.6	148	234
−18 08.0	+178 25.0	22 12 27.0	207	296							1 28 57.0	97	14
−17 20.0	−145 30.5	23 39 31.0	235	149	1 11 34.9	214	120	1 17 43.1	80	345	2 34 05.9	60	320
−16 30.0	−152 15.0	23 27 48.5	227	150							2 32 21.6	66	329

Dot leaders indicate the phenomenon occurs below the horizon. Blanks indicate the phenomenon does not occur for the location.

LIMB CORRECTIONS

The information below is based largely on the article, "Correcting Predictions of Solar Eclipse Contact Times for the Effects of Lunar Limb Irregularities", *J. Brit. Astron. Assoc.* 1983, **93**, 6, pp. 241-246, by David Herald of Canberra, A. C. T., Australia. Mr. Herald's charts for this eclipse appear on the next two pages.

For locations in the central path of a solar eclipse, predicted times of second and third contacts are computed on the assumption that the Moon is a smooth circular body. However, in the strict sense this is not true, and, in particular, the irregular limb of the Moon introduces a change into those predicted contact times which may potentially amount to several seconds at locations well away from the central line. The change is caused by two different effects of the irregular limb.

First, the position and motion of the Moon are calculated from gravitational theory which deals only with a point mass, or center of gravity. However, the observed eclipse phenomena are caused by the apparent figure, and the Moon is such an irregular body that the centers of figure and mass do not coincide. Therefore, in predicting the contacts, corrections have been applied to the lunar ephemeris for the offset of the center of figure from the center of mass (or motion), and a mean lunar profile radius, *k*, has been used in the calculations. (See *Elements of the Eclipse.*)

The predicted second and third contacts are defined as the instants at which the solar limb is tangential to the mean lunar limb, but does not intersect it at any point. However, applying this definition to the irregular true lunar limb, one can see by inspection of the profile (page 25) that for any given point of predicted contact on the smooth mean limb, there is some irregular valley feature in the vicinity whose innermost (deepest) point will define the true contact. Then the operational definition of the second and third contacts is whether or not any light from the photosphere is visible. In general, but not always, second contact will be later than predicted, and third contact earlier.

The plot of the lunar limb shows the difference between the true limb and the mean limb exaggerated 70 to 1 on the radial scale. If the solar limb relative to the mean lunar limb is plotted using the same exaggerated radial scale, at the time of predicted second or third contact, it forms an epicyclic curve separating from the lunar limb rapidly with position angle away from the predicted contact point. Furthermore, if this epicyclic curve representing the solar limb is plotted for a sequence of times at small intervals, the sequence of curves progresses essentially along the radial direction from the mean limb at the contact point. Hence, in effect, when this epicyclic curve is shifted radially so as to be tangent to the true irregular limb at some valley point which may lie well off the cited radius, the displacement of the solar limb from the predicted contact point, in seconds of arc, is ascertained for that position angle. The locus of such displacements for all position angles is a curve representing the displacement of the solar limb from the mean lunar limb at the true time it contacts the true lunar limb at any given position angle of contact. In other words, it is the operational lunar limb for predicting contact times.

To use this displacement curve to correct predicted contact times for the mean limb, it is necessary to relate the displacement in seconds of arc to a time interval. This is most conveniently achieved by plotting along with the displacement curve already described another curve representing the locus of the displacement of the solar limb at each position angle at some specified constant time interval (e.g. 10 seconds) from the mean-limb contact time. The ratio of the displacement of the solar limb at true contact to the displacement in a constant time interval then gives directly the correction to be applied to account for the effect of the lunar limb features.

The first curve, for displacement from predicted contact, is nearly the same for the entire eclipse track, but the curve for displacement of the solar limb in 10 seconds is location-dependent and should be calculated for each major observing region in the path.

Overleaf is a pair of correction diagrams for Tasmania; a similar set of diagrams also is provided for New Zealand. Conceptually, time flows left to right. The left-hand diagram is for second contact, the right hand one is for third contact. The vertical line in each diagram represents the instant of the mean, smooth-limb, predicted contact. The smooth curved lines represent the relative displacement of the solar limb in 10 seconds. Position angles are marked on the vertical. The irregular curves running vertically represent the displacement at the instant of contact with the true, irregular limb, i.e., the operational lunar limb.

To get the correction for a specific location, first obtain the predicted times and position angles of the second and third contacts, either from the tables or by estimation as described elsewhere. On the vertical lines, find each position angle and lay a ruler from from that point to the associated point on the smooth solar limb displacement curve. Measure the distance between those two points, and the distance from the vertical line to the irregular displacement curve. Divide the second measure by the first and multiply by 10 to get the correction in seconds of time. For second contact, if the two curve points are on the same side of the vertical line, add the correction to the predicted time; otherwise, subtract. For third contact, if the two curve points are on the same side of the vertical line, subtract the correction from the predicted contact time; otherwise, add it.

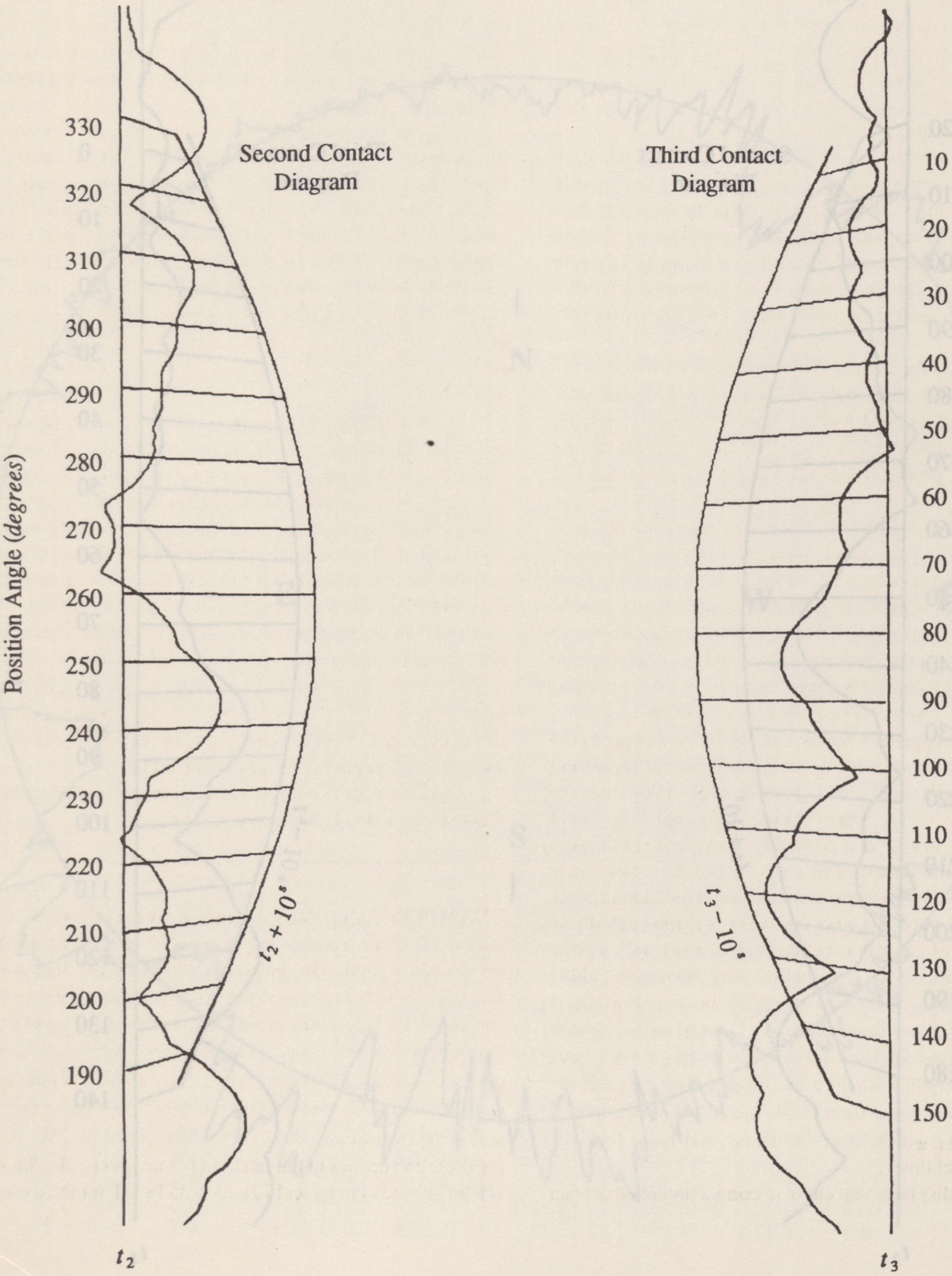
During the time interval between predicted and corrected times, Baily's Bead effects may appear.

EXAMPLE: At Smithton, Tasmania, from the Local Circumstances table, the position angles are 257° (second contact) and 80° (third contact). On the second contact (left) diagram, for angle 257°, the displacement curve lies about 10/44 of the distance to the solar limb curve, both curves on the same side of the vertical line; hence, the time correction is +2^{s}.3 Similarly, on the third contact (right) diagram, for angle 80°, the ratio of the distances is approximately 22/44 with both curves on the same side of the vertical line; thus, the time correction is –5^{s}.0. Applying these corrections to the predicted times gives 22h 18m 30.2s UT for second contact and 22h 25m 05.0s UT for third contact.

LUNAR PROFILE CORRECTION DIAGRAMS

Tasmania, Australia

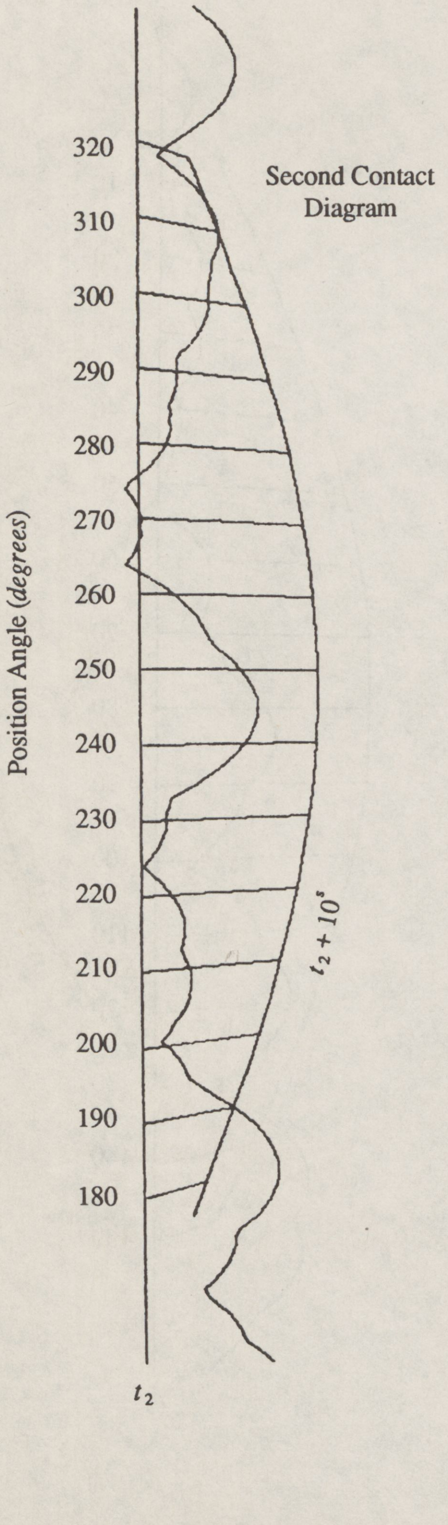
David Herald
P. O. Box 254
Woden, A. C. T. 2606
AUSTRALIA

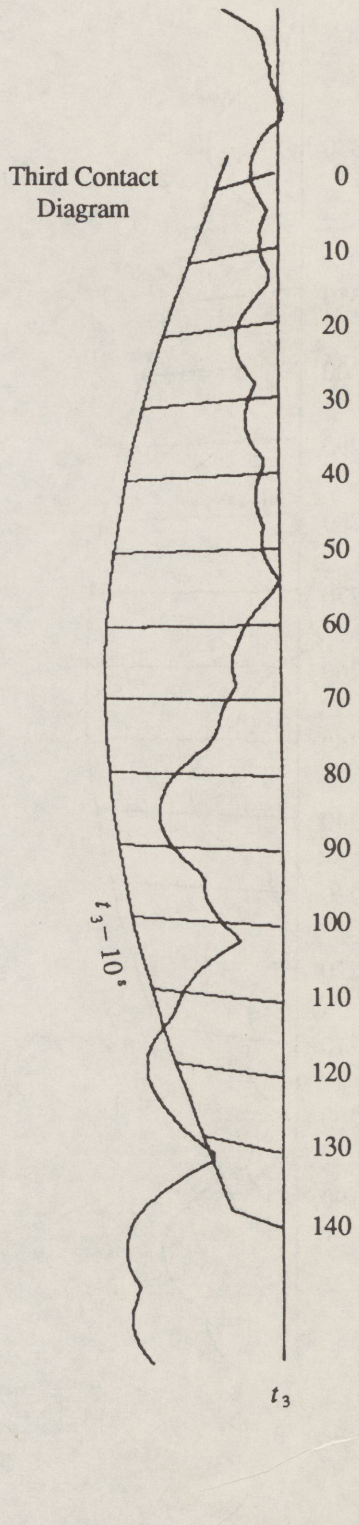


LUNAR PROFILE CORRECTION DIAGRAMS

New Zealand

David Herald
P. O. Box 254
Woden, A. C. T. 2606
AUSTRALIA

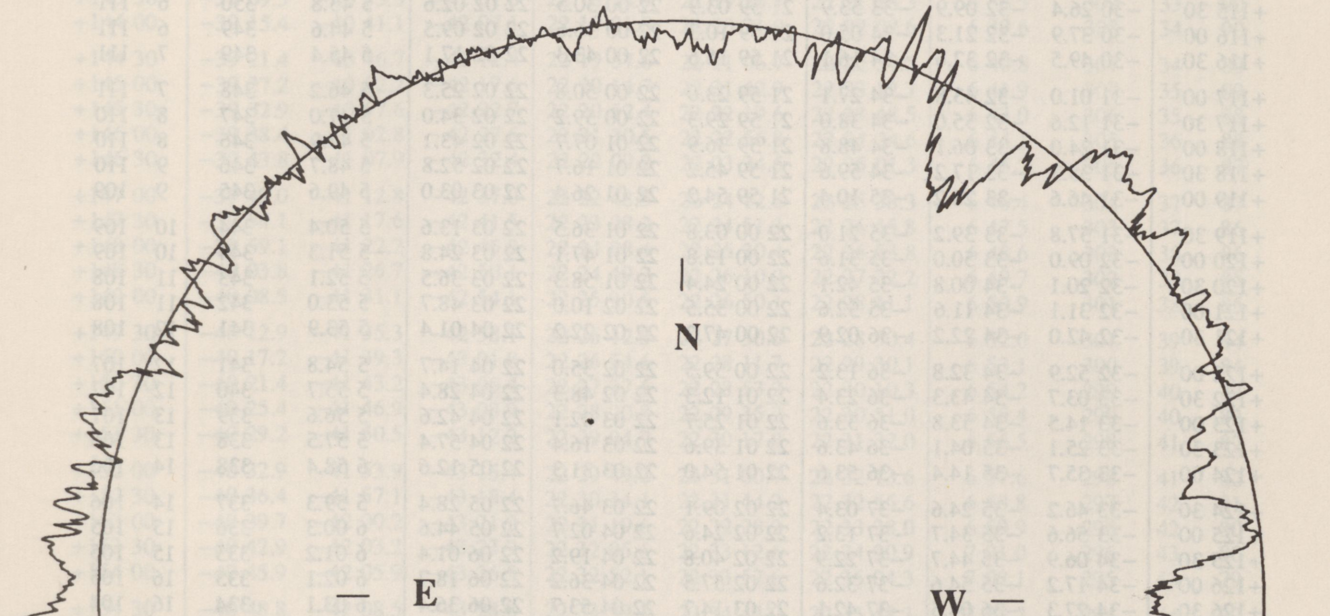




LUNAR LIMB PROFILE

Radial Scale at Limb: approx. 4 arcsec/inch

true limb: *irregular curve*
mean limb: *smooth curve*



SURFACE PATH OF THE ANNULAR PHASE OVER LAND

Longitude	Latitude of:			Universal Time at:			On Central Line			
	Northern Limit	Central Line	Southern Limit	Northern Limit	Central Line	Southern Limit	Maximum Duration	Path Width	Sun's Alt.	Az.
° ′	° ′	° ′	° ′	h m s	h m s	h m s	m s	km	°	°
+112 00	.. ...	−30 48.8	.. ...	.. ..	22 00 00.8	.. ..	5 38.3	355	2	113
+112 30	.. ...	−31 00.4	−32 46.1	.. ..	22 00 05.1	22 01 31.1	5 39.1	354	3	113
+113 00	.. ...	−31 12.0	−32 57.4	.. ..	22 00 09.3	22 01 36.3	5 39.9	353	3	113
+113 30	.. ...	−31 23.6	−33 08.7	.. ..	22 00 13.5	22 01 41.4	5 40.6	353	4	112
+114 00	.. ...	−31 35.1	−33 20.0	.. ..	22 00 17.7	22 01 46.6	5 41.4	352	4	112
+114 30	.. ...	−31 46.7	−33 31.3	.. ..	22 00 22.0	22 01 51.8	5 42.2	351	5	112
+115 00	.. ...	−31 58.3	−33 42.7	.. ..	22 00 26.2	22 01 56.9	5 43.0	351	5	112
+115 30	−30 26.4	−32 09.9	−33 53.9	21 59 03.9	22 00 30.5	22 02 02.6	5 43.8	350	6	111
+116 00	−30 37.9	−32 21.3	−34 05.0	21 59 10.3	22 00 36.6	22 02 09.5	5 44.6	349	6	111
+116 30	−30 49.5	−32 32.6	−34 16.1	21 59 16.6	22 00 43.3	22 02 17.1	5 45.4	349	7	111
+117 00	−31 01.0	−32 43.8	−34 27.1	21 59 23.0	22 00 50.8	22 02 25.3	5 46.2	348	7	111
+117 30	−31 12.6	−32 55.0	−34 38.0	21 59 29.3	22 00 59.2	22 02 34.0	5 47.0	347	8	110
+118 00	−31 24.0	−33 06.1	−34 48.8	21 59 36.9	22 01 07.7	22 02 43.1	5 47.9	346	8	110
+118 30	−31 35.3	−33 17.2	−34 59.6	21 59 45.2	22 01 16.7	22 02 52.8	5 48.7	346	9	110
+119 00	−31 46.6	−33 28.2	−35 10.4	21 59 54.2	22 01 26.4	22 03 03.0	5 49.6	345	9	109
+119 30	−31 57.8	−33 39.2	−35 21.0	22 00 03.8	22 01 36.5	22 03 13.6	5 50.4	344	10	109
+120 00	−32 09.0	−33 50.0	−35 31.6	22 00 13.8	22 01 47.1	22 03 24.8	5 51.3	344	10	109
+120 30	−32 20.1	−34 00.8	−35 42.1	22 00 24.4	22 01 58.3	22 03 36.5	5 52.1	343	11	108
+121 00	−32 31.1	−34 11.6	−35 52.6	22 00 35.5	22 02 10.0	22 03 48.7	5 53.0	342	11	108
+121 30	−32 42.0	−34 22.2	−36 02.9	22 00 47.2	22 02 22.2	22 04 01.4	5 53.9	341	12	108
+122 00	−32 52.9	−34 32.8	−36 13.2	22 00 59.5	22 02 35.0	22 04 14.7	5 54.8	341	12	107
+122 30	−33 03.7	−34 43.3	−36 23.4	22 01 12.3	22 02 48.3	22 04 28.4	5 55.7	340	12	107
+123 00	−33 14.5	−34 53.8	−36 33.6	22 01 25.7	22 03 02.1	22 04 42.6	5 56.6	339	13	107
+123 30	−33 25.1	−35 04.1	−36 43.6	22 01 39.6	22 03 16.4	22 04 57.4	5 57.5	338	13	106
+124 00	−33 35.7	−35 14.4	−36 53.6	22 01 54.0	22 03 31.3	22 05 12.6	5 58.4	338	14	106
+124 30	−33 46.2	−35 24.6	−37 03.4	22 02 09.1	22 03 46.7	22 05 28.4	5 59.3	337	14	106
+125 00	−33 56.6	−35 34.7	−37 13.2	22 02 24.6	22 04 02.7	22 05 44.6	6 00.3	336	15	105
+125 30	−34 06.9	−35 44.7	−37 22.9	22 02 40.8	22 04 19.2	22 06 01.4	6 01.2	335	15	105
+126 00	−34 17.2	−35 54.6	−37 32.6	22 02 57.5	22 04 36.2	22 06 18.7	6 02.1	335	16	105
+126 30	−34 27.3	−36 04.5	−37 42.1	22 03 14.7	22 04 53.7	22 06 36.4	6 03.1	334	16	104
+127 00	−34 37.4	−36 14.2	−37 51.5	22 03 32.5	22 05 11.8	22 06 54.7	6 04.0	333	17	104
+127 30	−34 47.4	−36 23.9	−38 00.8	22 03 50.8	22 05 30.4	22 07 13.5	6 05.0	332	17	104
+128 00	−34 57.3	−36 33.5	−38 10.1	22 04 09.7	22 05 49.5	22 07 32.7	6 06.0	332	18	103
+128 30	−35 07.1	−36 42.9	−38 19.2	22 04 29.2	22 06 09.1	22 07 52.5	6 06.9	331	18	103
+129 00	−35 16.8	−36 52.3	−38 28.3	22 04 49.2	22 06 29.3	22 08 12.8	6 07.9	330	19	103
+129 30	−35 26.4	−37 01.6	−38 37.2	22 05 09.7	22 06 49.9	22 08 33.5	6 08.9	329	19	102
+130 00	−35 35.9	−37 10.8	−38 46.1	22 05 30.8	22 07 11.1	22 08 54.7	6 09.9	329	20	102
+130 30	−35 45.3	−37 19.8	−38 54.8	22 05 52.5	22 07 32.9	22 09 16.5	6 10.9	328	20	102
+131 00	−35 54.6	−37 28.8	−39 03.4	22 06 14.7	22 07 55.1	22 09 38.7	6 11.9	327	21	101
+131 30	−36 03.8	−37 37.7	−39 12.0	22 06 37.4	22 08 17.9	22 10 01.4	6 12.9	326	21	101
+132 00	−36 12.9	−37 46.4	−39 20.4	22 07 00.7	22 08 41.1	22 10 24.6	6 13.9	326	22	100
+132 30	−36 21.9	−37 55.1	−39 28.7	22 07 24.6	22 09 04.9	22 10 48.3	6 14.9	325	22	100
+133 00	−36 30.7	−38 03.6	−39 36.9	22 07 49.0	22 09 29.2	22 11 12.4	6 16.0	324	23	100
+133 30	−36 39.5	−38 12.1	−39 45.0	22 08 13.9	22 09 54.0	22 11 37.1	6 17.0	323	23	99
+134 00	−36 48.2	−38 20.4	−39 53.0	22 08 39.4	22 10 19.4	22 12 02.2	6 18.0	323	24	99
+134 30	−36 56.7	−38 28.6	−40 00.8	22 09 05.4	22 10 45.2	22 12 27.8	6 19.1	322	24	98
+135 00	−37 05.1	−38 36.7	−40 08.6	22 09 31.9	22 11 11.5	22 12 53.8	6 20.1	321	25	98
+135 30	−37 13.4	−38 44.6	−40 16.2	22 09 59.0	22 11 38.4	22 13 20.4	6 21.2	320	25	98
+136 00	−37 21.6	−38 52.5	−40 23.7	22 10 26.6	22 12 05.7	22 13 47.4	6 22.2	320	26	97
+136 30	−37 29.7	−39 00.2	−40 31.1	22 10 54.8	22 12 33.6	22 14 14.9	6 23.3	319	26	97
+137 00	−37 37.6	−39 07.8	−40 38.4	22 11 23.5	22 13 02.0	22 14 42.8	6 24.3	318	27	96
+137 30	−37 45.5	−39 15.3	−40 45.6	22 11 52.8	22 13 30.8	22 15 11.3	6 25.4	317	27	96
+138 00	−37 53.2	−39 22.7	−40 52.6	22 12 22.5	22 14 00.2	22 15 40.2	6 26.5	317	28	95
+138 30	−38 00.8	−39 30.0	−40 59.5	22 12 52.8	22 14 30.0	22 16 09.5	6 27.6	316	28	95
+139 00	−38 08.2	−39 37.1	−41 06.3	22 13 23.7	22 15 00.4	22 16 39.3	6 28.6	315	29	95

SURFACE PATH OF THE ANNULAR PHASE OVER LAND

Longitude	Latitude of:			Universal Time at:			On Central Line			
	Northern Limit	Central Line	Southern Limit	Northern Limit	Central Line	Southern Limit	Maximum Duration	Path Width	Sun's Alt.	Az.
° ′	° ′	° ′	° ′	h m s	h m s	h m s	m s	km	°	°
+139 30	−38 15.5	−39 44.1	−41 13.0	22 13 55.0	22 15 31.2	22 17 09.6	6 29.7	315	29	94
+140 00	−38 22.7	−39 50.9	−41 19.5	22 14 26.9	22 16 02.6	22 17 40.3	6 30.8	314	30	94
+140 30	−38 29.8	−39 57.7	−41 25.9	22 14 59.3	22 16 34.4	22 18 11.5	6 31.9	313	30	93
+141 00	−38 36.7	−40 04.3	−41 32.2	22 15 32.3	22 17 06.7	22 18 43.2	6 33.0	312	31	93
+141 30	−38 43.5	−40 10.7	−41 38.3	22 16 05.8	22 17 39.6	22 19 15.3	6 34.1	312	31	92
+142 00	−38 50.2	−40 17.1	−41 44.4	22 16 39.8	22 18 12.9	22 19 47.9	6 35.2	311	32	92
+142 30	−38 56.7	−40 23.3	−41 50.2	22 17 14.3	22 18 46.7	22 20 20.9	6 36.3	310	32	91
+143 00	−39 03.1	−40 29.3	−41 56.0	22 17 49.3	22 19 20.9	22 20 54.3	6 37.4	309	33	91
+143 30	−39 09.3	−40 35.3	−42 01.6	22 18 24.9	22 19 55.7	22 21 28.3	6 38.5	309	33	90
+144 00	−39 15.4	−40 41.1	−42 07.1	22 19 01.0	22 20 31.0	22 22 02.6	6 39.6	308	34	90
+144 30	−39 21.4	−40 46.7	−42 12.4	22 19 37.6	22 21 06.7	22 22 37.5	6 40.8	307	34	89
+145 00	−39 27.2	−40 52.2	−42 17.6	22 20 14.7	22 21 42.9	22 23 12.7	6 41.9	307	35	89
+145 30	−39 32.9	−40 57.6	−42 22.7	22 20 52.4	22 22 19.6	22 23 48.5	6 43.0	306	35	88
+146 00	−39 38.4	−41 02.8	−42 27.6	22 21 30.5	22 22 56.8	22 24 24.6	6 44.1	305	36	88
+146 30	−39 43.8	−41 07.9	−42 32.4	22 22 09.2	22 23 34.5	22 25 01.3	6 45.2	305	36	87
+147 00	−39 49.0	−41 12.8	−42 37.0	22 22 48.5	22 24 12.6	22 25 38.3	6 46.4	304	37	87
+147 30	−39 54.1	−41 17.6	−42 41.5	22 23 28.2	22 24 51.3	22 26 15.8	6 47.5	303	37	86
+148 00	−39 59.1	−41 22.2	−42 45.9	22 24 08.4	22 25 30.4	22 26 53.8	6 48.6	303	38	86
+148 30	−40 03.8	−41 26.7	−42 50.1	22 24 49.2	22 26 10.0	22 27 32.2	6 49.7	302	38	85
+149 00	−40 08.5	−41 31.1	−42 54.1	22 25 30.5	22 26 50.1	22 28 11.1	6 50.9	301	38	85
+149 30	−40 12.9	−41 35.3	−42 58.1	22 26 12.3	22 27 30.6	22 28 50.4	6 52.0	301	39	84
+150 00	−40 17.2	−41 39.3	−43 01.8	22 26 54.6	22 28 11.7	22 29 30.1	6 53.1	300	39	84
+150 30	−40 21.4	−41 43.2	−43 05.4	22 27 37.5	22 28 53.2	22 30 10.3	6 54.2	299	40	83
+151 00	−40 25.4	−41 46.9	−43 08.9	22 28 20.8	22 29 35.2	22 30 51.0	6 55.4	299	40	83
+151 30	−40 29.2	−41 50.5	−43 12.2	22 29 04.7	22 30 17.8	22 31 32.0	6 56.5	298	41	82
+152 00	−40 32.9	−41 53.9	−43 15.4	22 29 49.2	22 31 00.7	22 32 13.6	6 57.6	298	41	82
+152 30	−40 36.4	−41 57.1	−43 18.4	22 30 34.1	22 31 44.2	22 32 55.6	6 58.8	297	42	81
+153 00	−40 39.7	−42 00.2	−43 21.2	22 31 19.6	22 32 28.2	22 33 38.0	6 59.9	296	42	80
+153 30	−40 42.9	−42 03.2	−43 23.9	22 32 05.6	22 33 12.6	22 34 20.9	7 01.0	296	43	80
+154 00	−40 45.9	−42 05.9	−43 26.5	22 32 52.1	22 33 57.6	22 35 04.3	7 02.1	295	43	79
+154 30	−40 48.8	−42 08.5	−43 28.8	22 33 39.1	22 34 43.0	22 35 48.1	7 03.2	294	44	79
+155 00	−40 51.4	−42 11.0	−43 31.1	22 34 26.7	22 35 28.9	22 36 32.4	7 04.3	294	44	78
+155 30	−40 53.9	−42 13.3	−43 33.1	22 35 14.8	22 36 15.4	22 37 17.1	7 05.5	293	45	77
+156 00	−40 56.3	−42 15.4	−43 35.0	22 36 03.5	22 37 02.3	22 38 02.3	7 06.6	293	45	77
+156 30	−40 58.4	−42 17.3	−43 36.7	22 36 52.7	22 37 49.7	22 38 48.0	7 07.7	292	46	76
+157 00	−41 00.4	−42 19.1	−43 38.3	22 37 42.4	22 38 37.6	22 39 34.1	7 08.8	292	46	76
+157 30	−41 02.2	−42 20.7	−43 39.7	22 38 32.7	22 39 26.0	22 40 20.7	7 09.9	291	47	75
+158 00	−41 03.8	−42 22.1	−43 40.9	22 39 23.5	22 40 15.0	22 41 07.8	7 11.0	290	47	74
+158 30	−41 05.2	−42 23.3	−43 42.0	22 40 14.9	22 41 04.4	22 41 55.3	7 12.1	290	48	74
+159 00	−41 06.5	−42 24.4	−43 42.9	22 41 06.8	22 41 54.4	22 42 43.3	7 13.1	289	48	73
+159 30	−41 07.5	−42 25.3	−43 43.6	22 41 59.3	22 42 44.9	22 43 31.8	7 14.2	289	49	72
+160 00	−41 08.4	−42 26.0	−43 44.2	22 42 52.3	22 43 35.8	22 44 20.8	7 15.3	288	49	72
+160 30	−41 09.1	−42 26.5	−43 44.6	22 43 45.9	22 44 27.4	22 45 10.3	7 16.4	288	50	71
+161 00	−41 09.6	−42 26.9	−43 44.8	22 44 40.1	22 45 19.4	22 46 00.2	7 17.4	287	50	70
+161 30	−41 09.9	−42 27.0	−43 44.8	22 45 34.8	22 46 12.0	22 46 50.7	7 18.5	287	51	69
+162 00	−41 10.0	−42 27.0	−43 44.6	22 46 30.1	22 47 05.1	22 47 41.6	7 19.5	286	51	69
+162 30	−41 09.9	−42 26.8	−43 44.3	22 47 26.0	22 47 58.7	22 48 33.1	7 20.6	286	52	68
+163 00	−41 09.7	−42 26.4	−43 43.8	22 48 22.5	22 48 52.9	22 49 25.1	7 21.6	285	52	67
+163 30	−41 09.2	−42 25.8	−43 43.1	22 49 19.5	22 49 47.7	22 50 17.5	7 22.6	285	53	66
+164 00	−41 08.5	−42 25.0	−43 42.2	22 50 17.2	22 50 43.0	22 51 10.5	7 23.6	284	53	66
+164 30	−41 07.6	−42 24.0	−43 41.1	22 51 15.4	22 51 38.8	22 52 04.0	7 24.6	284	54	65
+165 00	−41 06.5	−42 22.9	−43 39.8	22 52 14.3	22 52 35.2	22 52 58.1	7 25.6	283	54	64
+165 30	−41 05.2	−42 21.5	−43 38.4	22 53 13.7	22 53 32.2	22 53 52.6	7 26.6	283	55	63
+166 00	−41 03.7	−42 19.9	−43 36.7	22 54 13.8	22 54 29.8	22 54 47.7	7 27.6	283	55	63
+166 30	−41 02.0	−42 18.1	−43 34.9	22 55 14.5	22 55 27.9	22 55 43.4	7 28.5	282	56	62

SURFACE PATH OF THE ANNULAR PHASE OVER LAND

Longitude	Latitude of:			Universal Time at:			On Central Line			
	Northern Limit	Central Line	Southern Limit	Northern Limit	Central Line	Southern Limit	Maximum Duration	Path Width	Sun's Alt.	Az.
° ′	° ′	° ′	° ′	h m s	h m s	h m s	m s	km	°	°
+167 00	−41 00.1	−42 16.1	−43 32.9	22 56 15.8	22 56 26.6	22 56 39.6	7 29.5	282	56	61
+167 30	−40 57.9	−42 13.9	−43 30.6	22 57 17.8	22 57 26.0	22 57 36.3	7 30.4	281	57	60
+168 00	−40 55.5	−42 11.5	−43 28.2	22 58 20.4	22 58 25.9	22 58 33.6	7 31.3	281	57	59
+168 30	−40 52.9	−42 08.9	−43 25.5	22 59 23.6	22 59 26.4	22 59 31.5	7 32.2	280	58	58
+169 00	−40 50.1	−42 06.1	−43 22.7	23 00 27.5	23 00 27.5	23 00 29.9	7 33.1	280	58	57
+169 30	−40 47.1	−42 03.0	−43 19.6	23 01 32.1	23 01 29.3	23 01 29.0	7 34.0	280	59	56
+170 00	−40 43.8	−41 59.8	−43 16.4	23 02 37.3	23 02 31.7	23 02 28.6	7 34.8	279	59	55
+170 30	−40 40.3	−41 56.3	−43 12.9	23 03 43.2	23 03 34.7	23 03 28.8	7 35.7	279	60	54
+171 00	−40 36.5	−41 52.5	−43 09.2	23 04 49.8	23 04 38.3	23 04 29.6	7 36.5	279	60	53
+171 30	−40 32.6	−41 48.6	−43 05.3	23 05 57.1	23 05 42.6	23 05 31.0	7 37.3	278	61	52
+172 00	−40 28.3	−41 44.4	−43 01.1	23 07 05.0	23 06 47.6	23 06 33.0	7 38.1	278	61	51
+172 30	−40 23.9	−41 40.0	−42 56.8	23 08 13.7	23 07 53.2	23 07 35.7	7 38.9	278	62	50
+173 00	−40 19.1	−41 35.4	−42 52.2	23 09 23.1	23 08 59.5	23 08 39.0	7 39.6	277	62	49
+173 30	−40 14.2	−41 30.5	−42 47.4	23 10 33.2	23 10 06.4	23 09 42.9	7 40.3	277	63	48
+174 00	−40 08.9	−41 25.3	−42 42.3	23 11 44.0	23 11 14.1	23 10 47.5	7 41.0	277	63	47
+174 30	−40 03.5	−41 20.0	−42 37.1	23 12 55.6	23 12 22.4	23 11 52.7	7 41.7	276	64	46
+175 00	−39 57.7	−41 14.3	−42 31.6	23 14 07.9	23 13 31.5	23 12 58.6	7 42.4	276	64	44
+175 30	−39 51.7	−41 08.4	−42 25.8	23 15 21.0	23 14 41.2	23 14 05.2	7 43.0	276	65	43
+176 00	−39 45.4	−41 02.3	−42 19.8	23 16 34.9	23 15 51.7	23 15 12.4	7 43.6	276	65	42
+176 30	−39 38.9	−40 55.9	−42 13.6	23 17 49.5	23 17 02.9	23 16 20.3	7 44.2	275	66	40
+177 00	−39 32.0	−40 49.2	−42 07.1	23 19 04.8	23 18 14.9	23 17 29.0	7 44.8	275	66	39
+177 30	−39 24.9	−40 42.3	−42 00.3	23 20 21.0	23 19 27.6	23 18 38.3	7 45.3	275	67	37
+178 00	−39 17.5	−40 35.1	−41 53.3	23 21 38.0	23 20 41.0	23 19 48.4	7 45.8	275	67	36
+178 30	−39 09.8	−40 27.6	−41 46.0	23 22 55.8	23 21 55.3	23 20 59.2	7 46.3	274	68	34
+179 00	−39 01.9	−40 19.9	−41 38.5	23 24 14.3	23 23 10.3	23 22 10.7	7 46.7	274	68	33
+179 30	−38 53.6	−40 11.9	−41 30.7	23 25 33.7	23 24 26.0	23 23 22.9	7 47.2	274	68	31
+180 00	−38 45.0	−40 03.5	−41 22.6	23 26 54.0	23 25 42.6	23 24 35.9	7 47.5	274	69	29
−179 30	−38 36.1	−39 54.9	−41 14.3	23 28 15.0	23 26 59.9	23 25 49.7	7 47.9	274	69	28
−179 00	−38 26.9	−39 46.0	−41 05.6	23 29 37.0	23 28 18.1	23 27 04.3	7 48.2	274	70	26
−178 30	−38 17.4	−39 36.8	−40 56.7	23 30 59.7	23 29 37.1	23 28 19.6	7 48.5	273	70	24
−178 00	−38 07.6	−39 27.3	−40 47.5	23 32 23.3	23 30 56.9	23 29 35.7	7 48.7	273	70	22
−177 30	−37 57.5	−39 17.5	−40 38.0	23 33 47.8	23 32 17.5	23 30 52.6	7 48.9	273	71	20
−177 00	−37 47.0	−39 07.4	−40 28.2	23 35 13.1	23 33 39.0	23 32 10.3	7 49.1	273	71	18
−176 30	−37 36.2	−38 56.9	−40 18.1	23 36 39.3	23 35 01.2	23 33 28.8	7 49.2	273	72	15
−176 00	−37 25.0	−38 46.2	−40 07.7	23 38 06.4	23 36 24.4	23 34 48.1	7 49.3	273	72	13
−175 30	−37 13.6	−38 35.1	−39 57.0	23 39 34.3	23 37 48.4	23 36 08.2	7 49.4	273	72	11
−175 00	−37 01.7	−38 23.7	−39 46.0	23 41 03.2	23 39 13.2	23 37 29.2	7 49.4	273	73	8
−174 30	−36 49.6	−38 11.9	−39 34.7	23 42 32.9	23 40 38.9	23 38 51.0	7 49.4	273	73	5
−174 00	−36 37.0	−37 59.9	−39 23.0	23 44 03.4	23 42 05.5	23 40 13.6	7 49.3	273	73	3
−173 30	−36 24.1	−37 47.4	−39 11.0	23 45 34.9	23 43 32.9	23 41 37.1	7 49.2	273	73	360
−173 00	−36 10.9	−37 34.7	−38 58.7	23 47 07.2	23 45 01.2	23 43 01.4	7 49.0	273	73	357
−172 30	−35 57.3	−37 21.6	−38 46.1	23 48 40.4	23 46 30.3	23 44 26.5	7 48.8	273	74	354
−172 00	−35 43.3	−37 08.1	−38 33.1	23 50 14.5	23 48 00.3	23 45 52.5	7 48.6	273	74	351
−171 30	−35 28.9	−36 54.3	−38 19.8	23 51 49.4	23 49 31.1	23 47 19.4	7 48.3	273	74	348
−171 00	−35 14.2	−36 40.1	−38 06.2	23 53 25.1	23 51 02.8	23 48 47.1	7 48.0	273	74	345
−170 30	−34 59.1	−36 25.5	−37 52.2	23 55 01.7	23 52 35.4	23 50 15.6	7 47.6	274	74	342
−170 00	−34 43.6	−36 10.6	−37 37.8	23 56 39.2	23 54 08.7	23 51 45.0	7 47.1	274	74	339
−155 00	−24 12.0	−25 58.8	−27 45.8	0 48 42.9	0 44 50.5	0 40 58.4	7 12.7	292	59	272
−154 30	−23 46.8	−25 34.1	−27 21.6	0 50 23.8	0 46 31.2	0 42 38.3	7 11.0	293	58	271
−154 00	−23 21.5	−25 09.2	−26 57.3	0 52 03.7	0 48 10.9	0 44 17.6	7 09.3	294	57	270
−153 30	−22 56.1	−24 44.3	−26 32.8	0 53 42.4	0 49 49.8	0 45 56.2	7 07.5	295	56	269
−153 00	−22 30.6	−24 19.2	−26 08.1	0 55 20.0	0 51 27.8	0 47 34.0	7 05.8	296	55	268
−152 30	−22 05.1	−23 54.0	−25 43.4	0 56 56.4	0 53 04.6	0 49 11.0	7 04.1	297	55	267
−152 00	−21 39.5	−23 28.8	−25 18.5	0 58 31.5	0 54 40.4	0 50 47.0	7 02.3	299	54	266
−151 30	−21 13.9	−23 03.5	−24 53.6	1 00 05.2	0 56 15.0	0 52 22.1	7 00.6	300	53	265
−151 00	−20 48.3	−22 38.2	−24 28.6	1 01 37.5	0 57 48.3	0 53 56.0	6 58.8	301	52	264
−150 30	−20 22.8	−22 12.9	−24 03.6	1 03 08.3	0 59 20.4	0 55 28.9	6 57.1	302	51	264

SURFACE PATH OF THE ANNULAR PHASE OVER LAND

	Latitude of:			Universal Time at:			On Central Line			
Longitude	Northern Limit	Central Line	Southern Limit	Northern Limit	Central Line	Southern Limit	Maximum Duration	Path Width	Sun's Alt.	Az.
° ′	° ′	° ′	° ′	h m s	h m s	h m s	m s	km	°	°
−150 00	−19 57.2	−21 47.6	−23 38.6	1 04 37.6	1 00 51.1	0 57 00.6	6 55.3	303	50	263
−149 30	−19 31.8	−21 22.3	−23 13.6	1 06 05.4	1 02 20.3	0 58 31.0	6 53.6	304	49	262
−149 00	−19 06.4	−20 57.1	−22 48.5	1 07 31.5	1 03 48.1	1 00 00.1	6 51.9	305	49	261
−148 30	−18 41.1	−20 31.9	−22 23.6	1 08 56.0	1 05 14.4	1 01 27.8	6 50.1	307	48	261
−148 00	−18 15.9	−20 06.8	−21 58.6	1 10 18.9	1 06 39.2	1 02 54.1	6 48.4	308	47	260
−147 30	−17 50.8	−19 41.8	−21 33.7	1 11 40.0	1 08 02.4	1 04 19.0	6 46.7	309	46	260
−147 00	−17 25.8	−19 16.9	−21 08.9	1 12 59.5	1 09 23.9	1 05 42.4	6 45.0	310	45	259
−146 30	−17 01.0	−18 52.1	−20 44.2	1 14 17.2	1 10 43.8	1 07 04.3	6 43.3	311	44	259
−146 00	−16 36.3	−18 27.4	−20 19.6	1 15 33.2	1 12 02.1	1 08 24.6	6 41.6	312	43	258
−145 30	−16 11.8	−18 02.9	−19 55.1	1 16 47.4	1 13 18.7	1 09 43.3	6 40.0	314	43	258
−145 00	−15 47.4	−17 38.6	−19 30.8	1 17 59.8	1 14 33.5	1 11 00.4	6 38.3	315	42	257
−144 30	−15 23.3	−17 14.3	−19 06.6	1 19 10.5	1 15 46.7	1 12 15.9	6 36.7	316	41	257
−144 00	−14 59.3	−16 50.3	−18 42.5	1 20 19.4	1 16 58.2	1 13 29.7	6 35.1	317	40	256
−143 30	−14 35.5	−16 26.5	−18 18.6	1 21 26.5	1 18 07.9	1 14 41.9	6 33.5	318	39	256
−143 00	−14 11.9	−16 02.8	−17 54.9	1 22 31.9	1 19 15.9	1 15 52.4	6 31.9	319	38	256
−142 30	−13 48.6	−15 39.3	−17 31.3	1 23 35.5	1 20 22.2	1 17 01.2	6 30.3	320	38	255
−142 00	−13 25.4	−15 16.1	−17 08.0	1 24 37.4	1 21 26.8	1 18 08.3	6 28.8	321	37	255
−141 30	−13 02.5	−14 53.0	−16 44.8	1 25 37.6	1 22 29.6	1 19 13.8	6 27.3	322	36	255
−141 00	−12 39.8	−14 30.2	−16 21.8	1 26 36.0	1 23 30.8	1 20 17.6	6 25.8	323	35	254
−140 30	−12 17.3	−14 07.5	−15 59.1	1 27 32.7	1 24 30.3	1 21 19.7	6 24.3	324	34	254
−140 00	−11 55.1	−13 45.1	−15 36.5	1 28 27.8	1 25 28.1	1 22 20.2	6 22.8	325	34	254
−139 30	−11 33.0	−13 23.0	−15 14.2	1 29 21.2	1 26 24.2	1 23 19.0	6 21.4	326	33	253
−139 00	−11 11.3	−13 01.0	−14 52.1	1 30 13.0	1 27 18.7	1 24 16.2	6 20.0	327	32	253
−138 30	−10 49.7	−12 39.3	−14 30.2	1 31 03.1	1 28 11.6	1 25 11.7	6 18.6	328	31	253
−138 00	−10 28.4	−12 17.8	−14 08.6	1 31 51.7	1 29 02.8	1 26 05.6	6 17.2	329	30	253
−137 30	−10 07.3	−11 56.6	−13 47.2	1 32 38.7	1 29 52.5	1 26 58.0	6 15.8	329	30	252
−137 00	− 9 46.5	−11 35.6	−13 26.0	1 33 24.1	1 30 40.6	1 27 48.7	6 14.5	330	29	252
−136 30	− 9 25.9	−11 14.8	−13 05.0	1 34 08.0	1 31 27.1	1 28 37.9	6 13.2	331	28	252
−136 00	− 9 05.6	−10 54.3	−12 44.3	1 34 50.4	1 32 12.2	1 29 25.6	6 11.9	332	27	252
−135 30	− 8 45.5	−10 34.0	−12 23.8	1 35 31.4	1 32 55.7	1 30 11.8	6 10.6	333	27	252
−135 00	− 8 25.6	−10 13.9	−12 03.5	1 36 10.8	1 33 37.8	1 30 56.4	6 09.3	333	26	251

PATH OF CENTRAL LINE AT FLYING ALTITUDES

U.T.	10000 Ft.		40000 Ft.		U.T.	10000 Ft.		40000 Ft.	
	Latitude	Longitude	Latitude	Longitude		Latitude	Longitude	Latitude	Longitude
h m	° ′	° ′	° ′	° ′	h m	° ′	° ′	° ′	° ′
Limits	−29 51.5	+109 36.7	−29 50.2	+109 40.0	22 59	−42 09.5	+168 18.2	−42 07.9	+168 21.8
22 00	−31 01.5	+112 34.5	−31 32.5	+114 01.1	23 00	−42 06.8	+168 47.7	−42 05.2	+168 51.2
22 01	−33 00.2	+117 46.4	−33 12.0	+118 24.9	23 01	−42 04.0	+169 17.0	−42 02.3	+169 20.4
22 02	−34 05.3	+120 44.7	−34 13.2	+121 13.8	23 02	−42 00.9	+169 45.9	−41 59.2	+169 49.2
22 03	−34 54.4	+123 04.0	−35 00.4	+123 28.5	23 03	−41 57.7	+170 14.6	−41 56.0	+170 17.8
22 04	−35 34.7	+125 02.5	−35 39.6	+125 24.1	23 04	−41 54.2	+170 43.0	−41 52.6	+170 46.1
22 05	−36 09.3	+126 47.3	−36 13.4	+127 06.8	23 05	−41 50.7	+171 11.2	−41 49.0	+171 14.2
22 06	−36 39.8	+128 22.4	−36 43.2	+128 40.4	23 06	−41 46.9	+171 39.1	−41 45.3	+171 41.9
22 07	−37 07.0	+129 50.1	−37 09.9	+130 06.9	23 07	−41 43.0	+172 06.7	−41 41.4	+172 09.5
22 08	−37 31.6	+131 11.9	−37 34.0	+131 27.7	23 08	−41 39.0	+172 34.0	−41 37.3	+172 36.7
22 09	−37 54.1	+132 28.9	−37 56.1	+132 43.9	23 09	−41 34.7	+173 01.2	−41 33.1	+173 03.7
22 10	−38 14.7	+133 42.0	−38 16.5	+133 56.1	23 10	−41 30.4	+173 28.0	−41 28.7	+173 30.5
22 11	−38 33.7	+134 51.6	−38 35.2	+135 05.1	23 11	−41 25.8	+173 54.6	−41 24.2	+173 57.0
22 12	−38 51.3	+135 58.2	−38 52.6	+136 11.1	23 12	−41 21.2	+174 21.0	−41 19.5	+174 23.3
22 13	−39 07.7	+137 02.2	−39 08.8	+137 14.7	23 13	−41 16.3	+174 47.2	−41 14.7	+174 49.4
22 14	−39 23.0	+138 03.9	−39 23.9	+138 15.9	23 14	−41 11.4	+175 13.1	−41 09.7	+175 15.2
22 15	−39 37.2	+139 03.6	−39 38.0	+139 15.1	23 15	−41 06.3	+175 38.7	−41 04.6	+175 40.8
22 16	−39 50.6	+140 01.4	−39 51.1	+140 12.5	23 16	−41 01.0	+176 04.2	−40 59.3	+176 06.2
22 17	−40 03.1	+140 57.5	−40 03.5	+141 08.3	23 17	−40 55.6	+176 29.4	−40 53.9	+176 31.3
22 18	−40 14.8	+141 52.1	−40 15.1	+142 02.5	23 18	−40 50.1	+176 54.5	−40 48.4	+176 56.3
22 19	−40 25.7	+142 45.2	−40 25.9	+142 55.4	23 19	−40 44.4	+177 19.3	−40 42.7	+177 21.0
22 20	−40 36.0	+143 37.1	−40 36.1	+143 46.9	23 20	−40 38.6	+177 43.9	−40 36.9	+177 45.5
22 21	−40 45.7	+144 27.7	−40 45.6	+144 37.3	23 21	−40 32.7	+178 08.3	−40 31.0	+178 09.8
22 22	−40 54.7	+145 17.2	−40 54.6	+145 26.5	23 22	−40 26.6	+178 32.4	−40 24.9	+178 33.9
22 23	−41 03.2	+146 05.7	−41 02.9	+146 14.7	23 23	−40 20.4	+178 56.4	−40 18.7	+178 57.8
22 24	−41 11.1	+146 53.1	−41 10.8	+147 01.9	23 24	−40 14.1	+179 20.2	−40 12.4	+179 21.6
22 25	−41 18.5	+147 39.7	−41 18.1	+147 48.2	23 25	−40 07.6	+179 43.8	−40 06.0	+179 45.1
22 26	−41 25.5	+148 25.3	−41 25.0	+148 33.7	23 26	−40 01.1	−179 52.8	−39 59.4	−179 51.6
22 27	−41 31.9	+149 10.2	−41 31.4	+149 18.3	23 27	−39 54.4	−179 29.6	−39 52.7	−179 28.5
22 28	−41 38.0	+149 54.2	−41 37.3	+150 02.1	23 28	−39 47.5	−179 06.5	−39 45.9	−179 05.5
22 29	−41 43.6	+150 37.5	−41 42.9	+150 45.2	23 29	−39 40.6	−178 43.7	−39 39.0	−178 42.7
22 30	−41 48.8	+151 20.1	−41 48.0	+151 27.6	23 30	−39 33.6	−178 21.0	−39 31.9	−178 20.1
22 31	−41 53.6	+152 02.0	−41 52.8	+152 09.4	23 31	−39 26.4	−177 58.5	−39 24.8	−177 57.7
22 32	−41 58.0	+152 43.3	−41 57.1	+152 50.5	23 32	−39 19.1	−177 36.2	−39 17.5	−177 35.4
22 33	−42 02.1	+153 23.9	−42 01.1	+153 30.9	23 33	−39 11.7	−177 14.0	−39 10.1	−177 13.4
22 34	−42 05.8	+154 04.0	−42 04.8	+154 10.8	23 34	−39 04.2	−176 52.1	−39 02.6	−176 51.4
22 35	−42 09.1	+154 43.4	−42 08.1	+154 50.1	23 35	−38 56.6	−176 30.2	−38 55.0	−176 29.7
22 36	−42 12.2	+155 22.3	−42 11.1	+155 28.9	23 36	−38 48.8	−176 08.6	−38 47.3	−176 08.1
22 37	−42 14.9	+156 00.7	−42 13.8	+156 07.1	23 37	−38 41.0	−175 47.1	−38 39.4	−175 46.7
22 38	−42 17.3	+156 38.6	−42 16.2	+156 44.8	23 38	−38 33.0	−175 25.7	−38 31.5	−175 25.4
22 39	−42 19.4	+157 16.0	−42 18.3	+157 22.0	23 39	−38 24.9	−175 04.5	−38 23.4	−175 04.2
22 40	−42 21.3	+157 52.9	−42 20.1	+157 58.8	23 40	−38 16.8	−174 43.5	−38 15.3	−174 43.3
22 41	−42 22.8	+158 29.3	−42 21.6	+158 35.1	23 41	−38 08.5	−174 22.6	−38 07.0	−174 22.4
22 42	−42 24.1	+159 05.3	−42 22.8	+159 10.9	23 42	−38 00.1	−174 01.8	−37 58.6	−174 01.7
22 43	−42 25.1	+159 40.8	−42 23.8	+159 46.3	23 43	−37 51.6	−173 41.2	−37 50.2	−173 41.2
22 44	−42 25.8	+160 15.9	−42 24.5	+160 21.3	23 44	−37 43.0	−173 20.7	−37 41.6	−173 20.8
22 45	−42 26.3	+160 50.6	−42 24.9	+160 55.9	23 45	−37 34.3	−173 00.4	−37 32.9	−173 00.5
22 46	−42 26.6	+161 24.9	−42 25.2	+161 30.0	23 46	−37 25.5	−172 40.2	−37 24.1	−172 40.3
22 47	−42 26.6	+161 58.8	−42 25.1	+162 03.8	23 47	−37 16.6	−172 20.1	−37 15.2	−172 20.3
22 48	−42 26.3	+162 32.4	−42 24.9	+162 37.2	23 48	−37 07.6	−172 00.2	−37 06.2	−172 00.4
22 49	−42 25.8	+163 05.5	−42 24.4	+163 10.2	23 49	−36 58.5	−171 40.3	−36 57.2	−171 40.7
22 50	−42 25.2	+163 38.3	−42 23.7	+163 42.9	23 50	−36 49.3	−171 20.6	−36 48.0	−171 21.0
22 51	−42 24.2	+164 10.7	−42 22.7	+164 15.2	23 51	−36 40.1	−171 01.0	−36 38.7	−171 01.5
22 52	−42 23.1	+164 42.8	−42 21.6	+164 47.1	23 52	−36 30.7	−170 41.6	−36 29.3	−170 42.1
22 53	−42 21.8	+165 14.5	−42 20.2	+165 18.8	23 53	−36 21.2	−170 22.2	−36 19.8	−170 22.8
22 54	−42 20.2	+165 45.9	−42 18.7	+165 50.1	23 54	−36 11.6	−170 03.0	−36 10.3	−170 03.6
22 55	−42 18.5	+166 17.0	−42 16.9	+166 21.0	23 55	−36 01.9	−169 43.8	−36 00.6	−169 44.5
22 56	−42 16.5	+166 47.8	−42 15.0	+166 51.7	23 56	−35 52.1	−169 24.8	−35 50.8	−169 25.5
22 57	−42 14.4	+167 18.2	−42 12.8	+167 22.0	23 57	−35 42.2	−169 05.9	−35 41.0	−169 06.7
22 58	−42 12.1	+167 48.4	−42 10.5	+167 52.0	23 58	−35 32.3	−168 47.1	−35 31.0	−168 47.9

PATH OF CENTRAL LINE AT FLYING ALTITUDES

U.T.	10000 Ft.		40000 Ft.		U.T.	10000 Ft.		40000 Ft.	
	Latitude	Longitude	Latitude	Longitude		Latitude	Longitude	Latitude	Longitude
h m	° ′	° ′	° ′	° ′	h m	° ′	° ′	° ′	° ′
23 59	−35 22.2	−168 28.3	−35 21.0	−168 29.2	0 54	−23 39.5	−152 14.0	−23 39.8	−152 17.9
0 00	−35 12.0	−168 09.7	−35 10.8	−168 10.6	0 55	−23 23.6	−151 55.1	−23 23.9	−151 59.1
0 01	−35 01.8	−167 51.1	−35 00.6	−167 52.2	0 56	−23 07.6	−151 36.1	−23 07.9	−151 40.1
0 02	−34 51.4	−167 32.7	−34 50.3	−167 33.7	0 57	−22 51.4	−151 16.9	−22 51.8	−151 21.0
0 03	−34 41.0	−167 14.3	−34 39.9	−167 15.4	0 58	−22 35.1	−150 57.6	−22 35.5	−151 01.7
0 04	−34 30.5	−166 56.0	−34 29.3	−166 57.2	0 59	−22 18.6	−150 38.1	−22 19.1	−150 42.3
0 05	−34 19.8	−166 37.8	−34 18.7	−166 39.0	1 00	−22 02.0	−150 18.4	−22 02.5	−150 22.7
0 06	−34 09.1	−166 19.7	−34 08.0	−166 21.0	1 01	−21 45.2	−149 58.5	−21 45.7	−150 02.8
0 07	−33 58.3	−166 01.6	−33 57.2	−166 03.0	1 02	−21 28.3	−149 38.3	−21 28.8	−149 42.8
0 08	−33 47.4	−165 43.6	−33 46.4	−165 45.0	1 03	−21 11.1	−149 18.0	−21 11.7	−149 22.5
0 09	−33 36.4	−165 25.7	−33 35.4	−165 27.2	1 04	−20 53.8	−148 57.4	−20 54.5	−149 02.0
0 10	−33 25.3	−165 07.9	−33 24.3	−165 09.4	1 05	−20 36.3	−148 36.6	−20 37.1	−148 41.3
0 11	−33 14.1	−164 50.1	−33 13.1	−164 51.6	1 06	−20 18.7	−148 15.5	−20 19.4	−148 20.3
0 12	−33 02.8	−164 32.3	−33 01.9	−164 33.9	1 07	−20 00.8	−147 54.1	−20 01.6	−147 59.0
0 13	−32 51.5	−164 14.7	−32 50.5	−164 16.3	1 08	−19 42.8	−147 32.5	−19 43.6	−147 37.4
0 14	−32 40.0	−163 57.0	−32 39.1	−163 58.8	1 09	−19 24.5	−147 10.5	−19 25.4	−147 15.6
0 15	−32 28.5	−163 39.5	−32 27.6	−163 41.2	1 10	−19 06.0	−146 48.2	−19 07.0	−146 53.4
0 16	−32 16.8	−163 22.0	−32 15.9	−163 23.8	1 11	−18 47.3	−146 25.6	−18 48.4	−146 30.8
0 17	−32 05.1	−163 04.5	−32 04.2	−163 06.3	1 12	−18 28.4	−146 02.6	−18 29.5	−146 07.9
0 18	−31 53.2	−162 47.0	−31 52.4	−162 48.9	1 13	−18 09.3	−145 39.2	−18 10.4	−145 44.6
0 19	−31 41.3	−162 29.6	−31 40.5	−162 31.6	1 14	−17 49.9	−145 15.4	−17 51.1	−145 20.9
0 20	−31 29.3	−162 12.3	−31 28.5	−162 14.3	1 15	−17 30.2	−144 51.1	−17 31.5	−144 56.8
0 21	−31 17.2	−161 54.9	−31 16.4	−161 57.0	1 16	−17 10.3	−144 26.4	−17 11.7	−144 32.2
0 22	−31 05.0	−161 37.6	−31 04.2	−161 39.7	1 17	−16 50.1	−144 01.2	−16 51.5	−144 07.1
0 23	−30 52.7	−161 20.3	−30 52.0	−161 22.5	1 18	−16 29.6	−143 35.4	−16 31.1	−143 41.5
0 24	−30 40.3	−161 03.1	−30 39.6	−161 05.3	1 19	−16 08.9	−143 09.1	−16 10.4	−143 15.3
0 25	−30 27.8	−160 45.8	−30 27.1	−160 48.1	1 20	−15 47.7	−142 42.2	−15 49.4	−142 48.6
0 26	−30 15.2	−160 28.6	−30 14.5	−160 30.9	1 21	−15 26.3	−142 14.7	−15 28.0	−142 21.2
0 27	−30 02.5	−160 11.4	−30 01.9	−160 13.7	1 22	−15 04.5	−141 46.4	−15 06.3	−141 53.1
0 28	−29 49.7	−159 54.1	−29 49.1	−159 56.6	1 23	−14 42.3	−141 17.5	−14 44.2	−141 24.3
0 29	−29 36.8	−159 36.9	−29 36.3	−159 39.4	1 24	−14 19.7	−140 47.7	−14 21.7	−140 54.7
0 30	−29 23.8	−159 19.7	−29 23.3	−159 22.2	1 25	−13 56.7	−140 17.0	−13 58.8	−140 24.3
0 31	−29 10.7	−159 02.5	−29 10.2	−159 05.1	1 26	−13 33.3	−139 45.5	−13 35.4	−139 52.9
0 32	−28 57.5	−158 45.2	−28 57.1	−158 47.9	1 27	−13 09.3	−139 12.9	−13 11.6	−139 20.5
0 33	−28 44.3	−158 28.0	−28 43.8	−158 30.7	1 28	−12 44.8	−138 39.2	−12 47.2	−138 47.1
0 34	−28 30.9	−158 10.7	−28 30.5	−158 13.5	1 29	−12 19.8	−138 04.3	−12 22.3	−138 12.5
0 35	−28 17.4	−157 53.4	−28 17.0	−157 56.2	1 30	−11 54.2	−137 28.1	−11 56.8	−137 36.6
0 36	−28 03.8	−157 36.1	−28 03.4	−157 39.0	1 31	−11 27.8	−136 50.5	−11 30.6	−136 59.2
0 37	−27 50.1	−157 18.8	−27 49.7	−157 21.7	1 32	−11 00.8	−136 11.2	−11 03.7	−136 20.3
0 38	−27 36.3	−157 01.4	−27 36.0	−157 04.3	1 33	−10 32.9	−135 30.1	−10 36.0	−135 39.5
0 39	−27 22.3	−156 44.0	−27 22.1	−156 47.0	1 34	−10 04.2	−134 46.9	−10 07.5	−134 56.8
0 40	−27 08.3	−156 26.5	−27 08.1	−156 29.5	1 35	− 9 34.4	−134 01.5	− 9 37.9	−134 11.8
0 41	−26 54.2	−156 09.0	−26 54.0	−156 12.1	1 36	− 9 03.5	−133 13.4	− 9 07.2	−133 24.3
0 42	−26 39.9	−155 51.4	−26 39.8	−155 54.6	1 37	− 8 31.2	−132 22.2	− 8 35.3	−132 33.7
0 43	−26 25.6	−155 33.8	−26 25.4	−155 37.0	1 38	− 7 57.5	−131 27.3	− 8 01.8	−131 39.6
0 44	−26 11.1	−155 16.1	−26 11.0	−155 19.3	1 39	− 7 21.8	−130 28.1	− 7 26.6	−130 41.3
0 45	−25 56.5	−154 58.3	−25 56.4	−155 01.6	1 40	− 6 44.0	−129 23.5	− 6 49.2	−129 37.7
0 46	−25 41.8	−154 40.4	−25 41.7	−154 43.8	1 41	− 6 03.4	−128 12.1	− 6 09.1	−128 27.7
0 47	−25 26.9	−154 22.5	−25 26.9	−154 25.9	1 42	− 5 19.0	−126 51.6	− 5 25.5	−127 09.1
0 48	−25 12.0	−154 04.4	−25 12.0	−154 08.0	1 43	− 4 29.5	−125 18.3	− 4 37.2	−125 38.5
0 49	−24 56.9	−153 46.3	−24 56.9	−153 49.9	1 44	− 3 32.0	−123 24.9	− 3 41.4	−123 49.5
0 50	−24 41.7	−153 28.1	−24 41.8	−153 31.7	1 45	− 2 19.2	−120 52.4	− 2 32.3	−121 26.6
0 51	−24 26.3	−153 09.7	−24 26.5	−153 13.4	1 46	+ 0 15.1	−114 50.9	− 0 39.9	−117 13.0
0 52	−24 10.9	−152 51.3	−24 11.0	−152 55.0	Limits	+ 0 27.8	−114 18.5	+ 0 29.1	−114 21.6
0 53	−23 55.3	−152 32.7	−23 55.5	−152 36.5					

CORRECTIONS TO U.T. AND LATITUDE FOR ELEVATIONS ABOVE SEA LEVEL

Longitude	Latitude Corr.	U.T. Corr.	Longitude	Latitude Corr.	U.T. Corr.	Longitude	Latitude Corr.	U.T. Corr.	Longitude	Latitude Corr.	U.T. Corr.
° ′	″	s	° ′	″	s	° ′	″	s	° ′	″	s
+114 00	+4.646	−0.447	+139 00	+3.998	−0.396	+164 00	+2.717	−0.279	−171 00	+3.146	+0.047
+114 30	+4.877	−0.406	+139 30	+3.969	−0.395	+164 30	+2.701	−0.275	−170 30	+3.196	+0.056
+115 00	+5.108	−0.365	+140 00	+3.940	−0.394	+165 00	+2.685	−0.271	−170 00	+3.248	+0.066
+115 30	+5.323	−0.327	+140 30	+3.911	−0.393	+165 30	+2.670	−0.267	−155 00	+5.638	+0.374
+116 00	+5.289	−0.332	+141 00	+3.882	−0.392	+166 00	+2.655	−0.262	−154 30	+5.720	+0.382
+116 30	+5.148	−0.354	+141 30	+3.852	−0.391	+166 30	+2.641	−0.258	−154 00	+5.799	+0.390
+117 00	+5.070	−0.366	+142 00	+3.823	−0.390	+167 00	+2.628	−0.254	−153 30	+5.876	+0.397
+117 30	+4.987	−0.380	+142 30	+3.794	−0.389	+167 30	+2.615	−0.249	−153 00	+5.951	+0.404
+118 00	+4.982	−0.380	+143 00	+3.764	−0.388	+168 00	+2.603	−0.244	−152 30	+6.022	+0.411
+118 30	+4.987	−0.377	+143 30	+3.735	−0.386	+168 30	+2.592	−0.240	−152 00	+6.090	+0.417
+119 00	+4.958	−0.381	+144 00	+3.706	−0.385	+169 00	+2.582	−0.235	−151 30	+6.155	+0.423
+119 30	+4.941	−0.383	+144 30	+3.677	−0.384	+169 30	+2.572	−0.230	−151 00	+6.216	+0.428
+120 00	+4.931	−0.383	+145 00	+3.648	−0.382	+170 00	+2.564	−0.225	−150 30	+6.274	+0.433
+120 30	+4.907	−0.385	+145 30	+3.619	−0.381	+170 30	+2.556	−0.220	−150 00	+6.328	+0.438
+121 00	+4.891	−0.386	+146 00	+3.590	−0.379	+171 00	+2.548	−0.215	−149 30	+6.379	+0.442
+121 30	+4.874	−0.387	+146 30	+3.561	−0.378	+171 30	+2.542	−0.210	−149 00	+6.426	+0.446
+122 00	+4.853	−0.388	+147 00	+3.532	−0.376	+172 00	+2.537	−0.204	−148 30	+6.469	+0.450
+122 30	+4.836	−0.389	+147 30	+3.504	−0.374	+172 30	+2.533	−0.199	−148 00	+6.509	+0.453
+123 00	+4.814	−0.390	+148 00	+3.475	−0.372	+173 00	+2.529	−0.193	−147 30	+6.544	+0.456
+123 30	+4.795	−0.391	+148 30	+3.447	−0.370	+173 30	+2.527	−0.188	−147 00	+6.576	+0.458
+124 00	+4.773	−0.392	+149 00	+3.419	−0.368	+174 00	+2.525	−0.182	−146 30	+6.604	+0.461
+124 30	+4.753	−0.393	+149 30	+3.391	−0.366	+174 30	+2.525	−0.176	−146 00	+6.629	+0.463
+125 00	+4.731	−0.394	+150 00	+3.363	−0.364	+175 00	+2.526	−0.170	−145 30	+6.650	+0.464
+125 30	+4.710	−0.394	+150 30	+3.335	−0.362	+175 30	+2.527	−0.164	−145 00	+6.668	+0.465
+126 00	+4.687	−0.395	+151 00	+3.308	−0.360	+176 00	+2.530	−0.158	−144 30	+6.682	+0.466
+126 30	+4.664	−0.396	+151 30	+3.281	−0.358	+176 30	+2.535	−0.152	−144 00	+6.693	+0.467
+127 00	+4.641	−0.396	+152 00	+3.254	−0.355	+177 00	+2.540	−0.145	−143 30	+6.701	+0.468
+127 30	+4.617	−0.397	+152 30	+3.228	−0.353	+177 30	+2.547	−0.139	−143 00	+6.706	+0.468
+128 00	+4.594	−0.398	+153 00	+3.201	−0.351	+178 00	+2.554	−0.132	−142 30	+6.708	+0.468
+128 30	+4.569	−0.398	+153 30	+3.175	−0.348	+178 30	+2.564	−0.125	−142 00	+6.707	+0.468
+129 00	+4.545	−0.399	+154 00	+3.150	−0.345	+179 00	+2.574	−0.118	−141 30	+6.704	+0.467
+129 30	+4.520	−0.399	+154 30	+3.124	−0.343	+179 30	+2.586	−0.112	−141 00	+6.698	+0.467
+130 00	+4.495	−0.399	+155 00	+3.099	−0.340	+180 00	+2.600	−0.104	−140 30	+6.689	+0.466
+130 30	+4.469	−0.400	+155 30	+3.074	−0.337	−179 30	+2.615	−0.097	−140 00	+6.679	+0.465
+131 00	+4.443	−0.400	+156 00	+3.050	−0.334	−179 00	+2.631	−0.090	−139 30	+6.666	+0.464
+131 30	+4.417	−0.400	+156 30	+3.026	−0.331	−178 30	+2.650	−0.082	−139 00	+6.651	+0.463
+132 00	+4.391	−0.400	+157 00	+3.002	−0.328	−178 00	+2.669	−0.075	−138 30	+6.634	+0.461
+132 30	+4.364	−0.400	+157 30	+2.979	−0.325	−177 30	+2.691	−0.067	−138 00	+6.615	+0.460
+133 00	+4.337	−0.400	+158 00	+2.956	−0.322	−177 00	+2.714	−0.059	−137 30	+6.595	+0.458
+133 30	+4.310	−0.400	+158 30	+2.933	−0.319	−176 30	+2.739	−0.051	−137 00	+6.573	+0.456
+134 00	+4.282	−0.400	+159 00	+2.911	−0.316	−176 00	+2.766	−0.043	−136 30	+6.550	+0.455
+134 30	+4.255	−0.400	+159 30	+2.890	−0.312	−175 30	+2.795	−0.034	−136 00	+6.525	+0.453
+135 00	+4.227	−0.400	+160 00	+2.869	−0.309	−175 00	+2.825	−0.026	−135 30	+6.500	+0.451
+135 30	+4.199	−0.399	+160 30	+2.848	−0.306	−174 30	+2.858	−0.017	−135 00	+6.473	+0.449
+136 00	+4.170	−0.399	+161 00	+2.828	−0.302	−174 00	+2.893	−0.009			
+136 30	+4.142	−0.399	+161 30	+2.808	−0.298	−173 30	+2.929	+0.000			
+137 00	+4.114	−0.398	+162 00	+2.789	−0.295	−173 00	+2.968	+0.009			
+137 30	+4.085	−0.398	+162 30	+2.770	−0.291	−172 30	+3.009	+0.018			
+138 00	+4.056	−0.397	+163 00	+2.752	−0.287	−172 00	+3.052	+0.028			
+138 30	+4.027	−0.396	+163 30	+2.734	−0.283	−171 30	+3.098	+0.037			

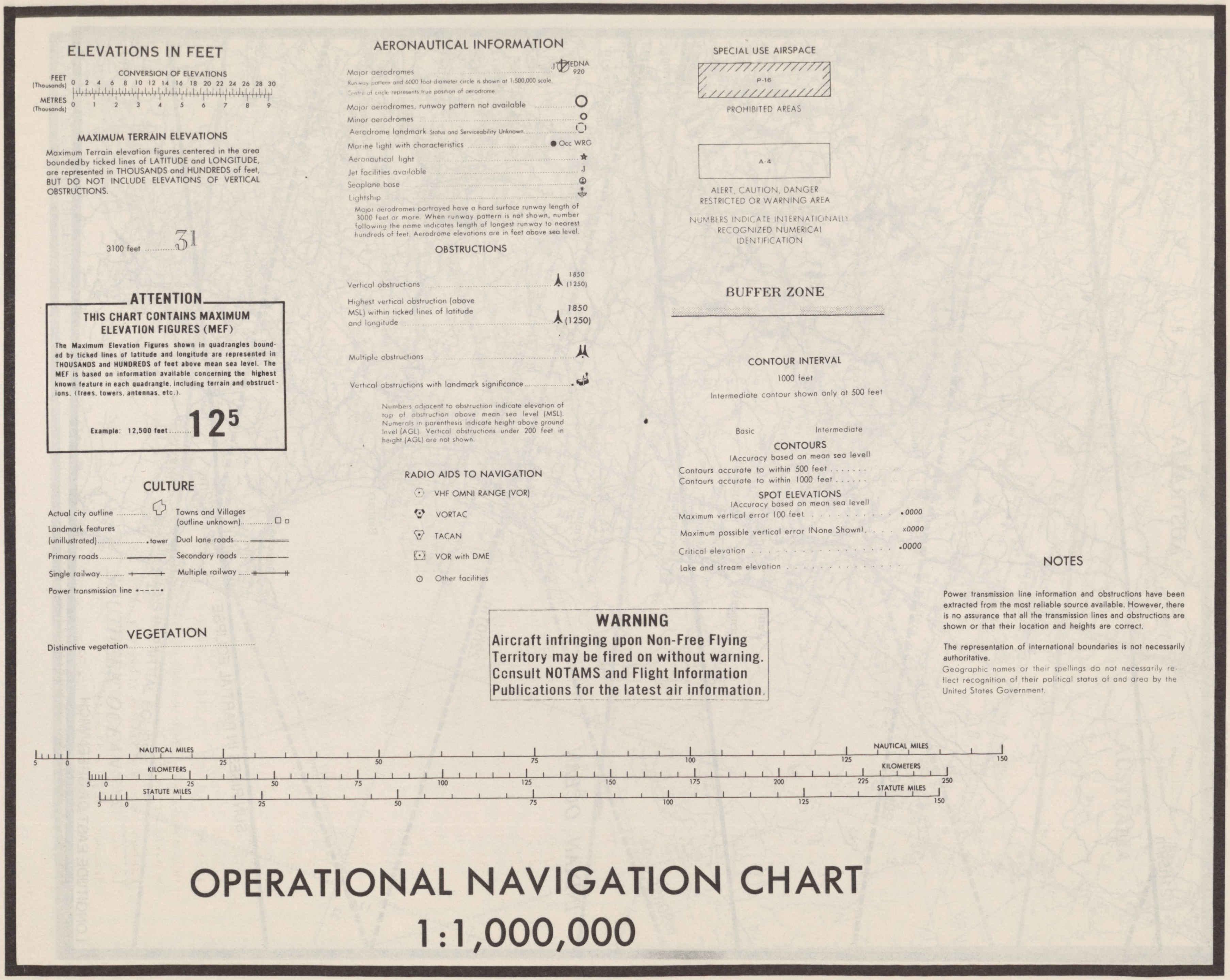
These corrections to latitude and time are to be applied to the corresponding surface data on page 26 to correct for elevation. *The units are seconds of arc or seconds of time per thousand feet.*

Example: Elevation 35000 ft. at longitude +119°.

Lat. corr.: +4″.958 × 35 = +173″.5 = +2′.9

Time corr.: $-0^{s}.381 \times 35 = -13^{s}.3$

Hence, for the longitude +119° tabular entry on page 26, the three latitude values should be shifted north by 2′.9, and the three times advanced (made earlier) by $13^{s}.3$.



ELEVATIONS IN FEET

CONVERSION OF ELEVATIONS

MAXIMUM TERRAIN ELEVATIONS

Maximum Terrain elevation figures centered in the area bounded by ticked lines of LATITUDE and LONGITUDE, are represented in THOUSANDS and HUNDREDS of feet, BUT DO NOT INCLUDE ELEVATIONS OF VERTICAL OBSTRUCTIONS.

3100 feet 31

ATTENTION

THIS CHART CONTAINS MAXIMUM ELEVATION FIGURES (MEF)

The Maximum Elevation Figures shown in quadrangles bounded by ticked lines of latitude and longitude are represented in THOUSANDS and HUNDREDS of feet above mean sea level. The MEF is based on information available concerning the highest known feature in each quadrangle, including terrain and obstructions, (trees, towers, antennas, etc.).

Example: 12,500 feet .... 12^5

CULTURE

Actual city outline ....
Towns and Villages (outline unknown)............ □ ▫
Landmark features (unillustrated)..................... • tower
Dual lane roads......
Primary roads...........
Secondary roads ....
Single railway..........
Multiple railway ......
Power transmission line •-----•

VEGETATION

Distinctive vegetation..

AERONAUTICAL INFORMATION

Major aerodromes .... J EDNA 920

Runway pattern and 6000 foot diameter circle is shown at 1:500,000 scale.

Centre of circle represents true position of aerodrome.

Major aerodromes, runway pattern not available .... ○
Minor aerodromes .... ○
Aerodrome landmark Status and Serviceability Unknown.........................
Marine light with characteristics .... ● Occ WRG
Aeronautical light .... ★
Jet facilities available .... J
Seaplane base ....
Lightship ....

Major aerodromes portrayed have a hard surface runway length of 3000 feet or more. When runway pattern is not shown, number following the name indicates length of longest runway to nearest hundreds of feet. Aerodrome elevations are in feet above sea level.

OBSTRUCTIONS

Vertical obstructions 1850 (1250)

Highest vertical obstruction (above MSL) within ticked lines of latitude and longitude 1850 (1250)

Multiple obstructions ....

Vertical obstructions with landmark significance ....

Numbers adjacent to obstruction indicate elevation of top of obstruction above mean sea level (MSL). Numerals in parenthesis indicate height above ground level (AGL). Vertical obstructions under 200 feet in height (AGL) are not shown.

RADIO AIDS TO NAVIGATION

VHF OMNI RANGE (VOR)
VORTAC
TACAN
VOR with DME
Other facilities

WARNING

Aircraft infringing upon Non-Free Flying Territory may be fired on without warning. Consult NOTAMS and Flight Information Publications for the latest air information.

SPECIAL USE AIRSPACE

PROHIBITED AREAS

ALERT, CAUTION, DANGER
RESTRICTED OR WARNING AREA

NUMBERS INDICATE INTERNATIONALLY
RECOGNIZED NUMERICAL
IDENTIFICATION

BUFFER ZONE

CONTOUR INTERVAL

1000 feet

Intermediate contour shown only at 500 feet

Basic Intermediate

CONTOURS

(Accuracy based on mean sea level)

Contours accurate to within 500 feet ....
Contours accurate to within 1000 feet ......

SPOT ELEVATIONS

(Accuracy based on mean sea level)

Maximum vertical error 100 feet. . . . . •0000
Maximum possible vertical error (None Shown). . . . x0000
Critical elevation 0000
Lake and stream elevation . . . .

NOTES

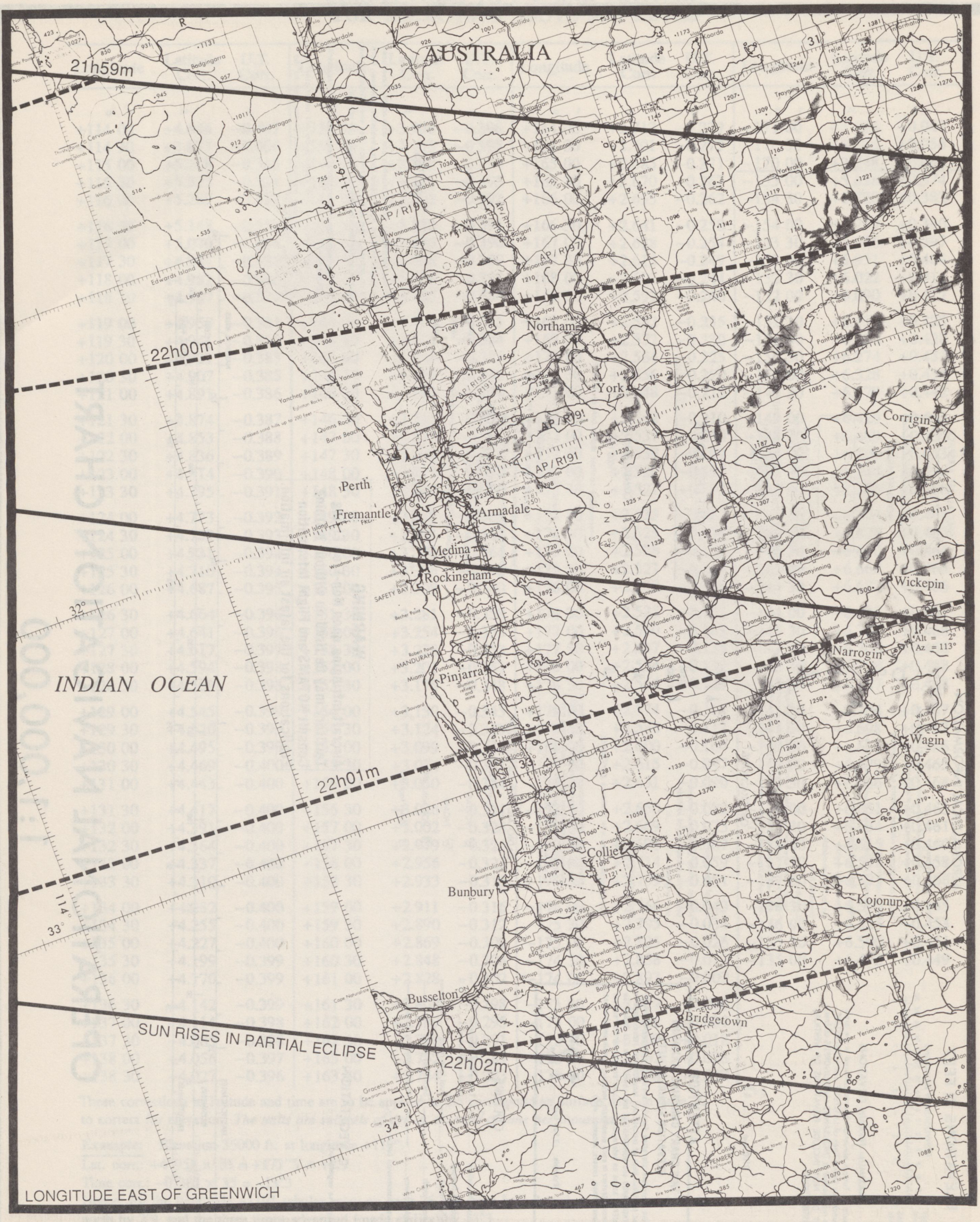
Power transmission line information and obstructions have been extracted from the most reliable source available. However, there is no assurance that all the transmission lines and obstructions are shown or that their location and heights are correct.

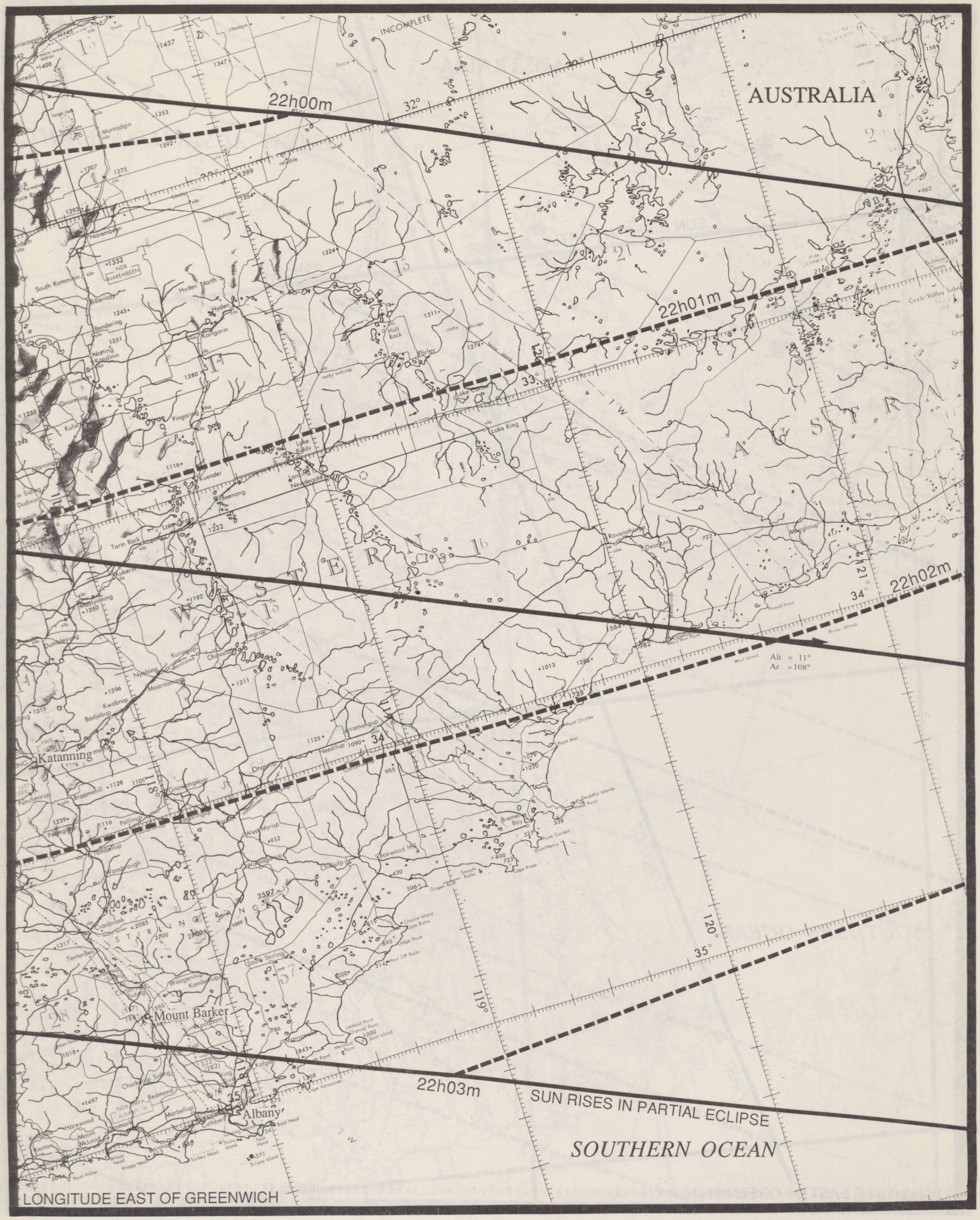
The representation of international boundaries is not necessarily authoritative.

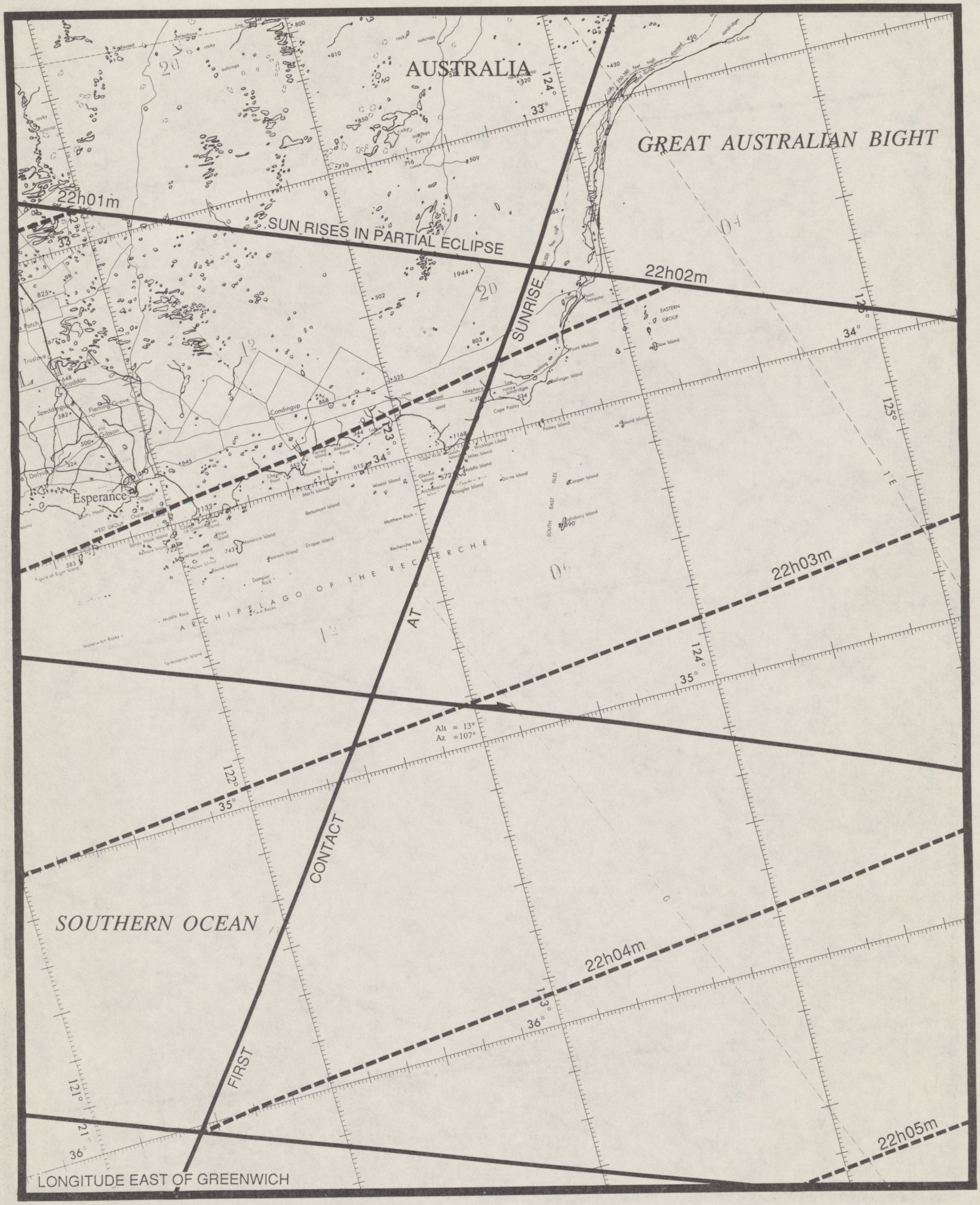
Geographic names or their spellings do not necessarily reflect recognition of their political status of and area by the United States Government.

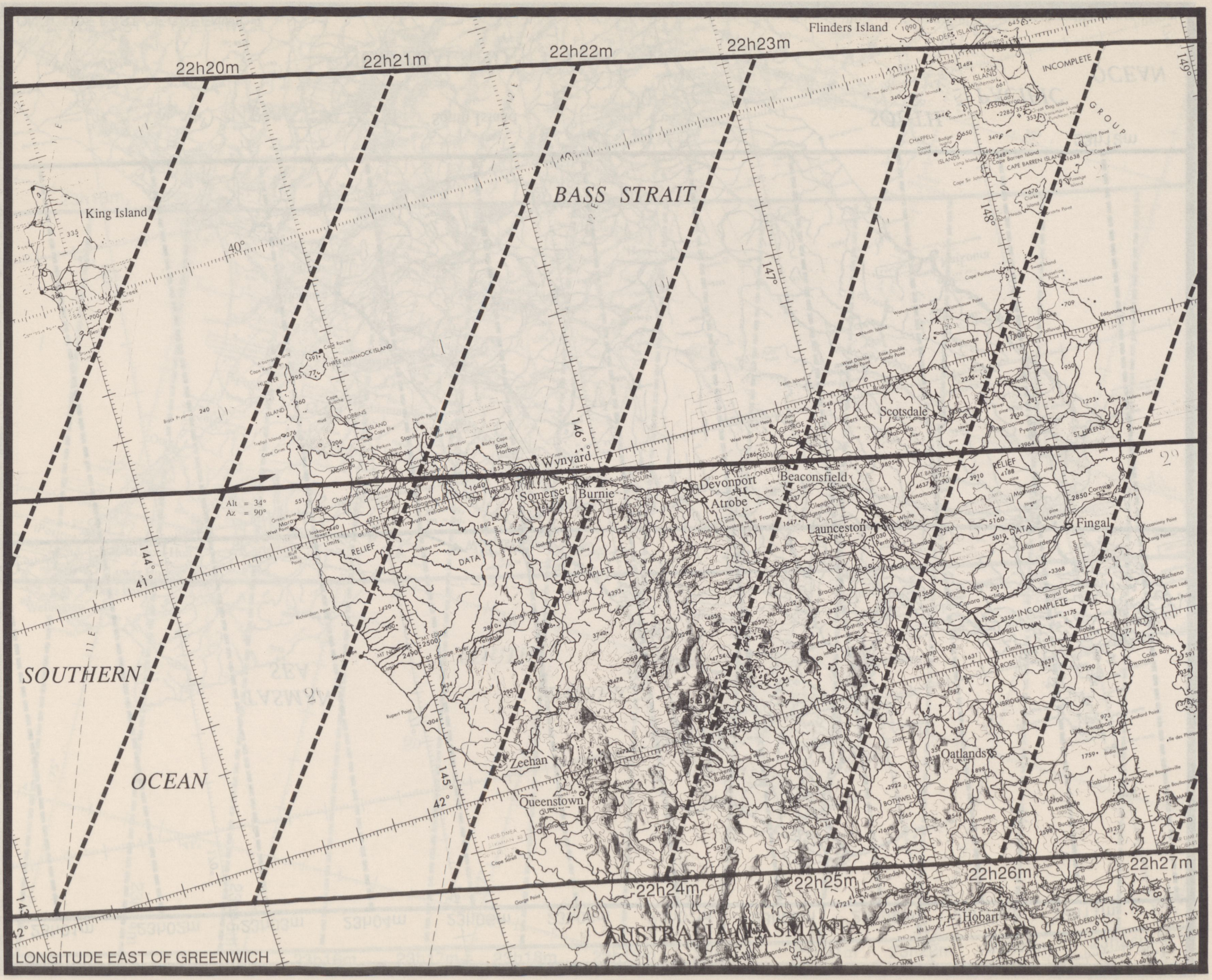
OPERATIONAL NAVIGATION CHART

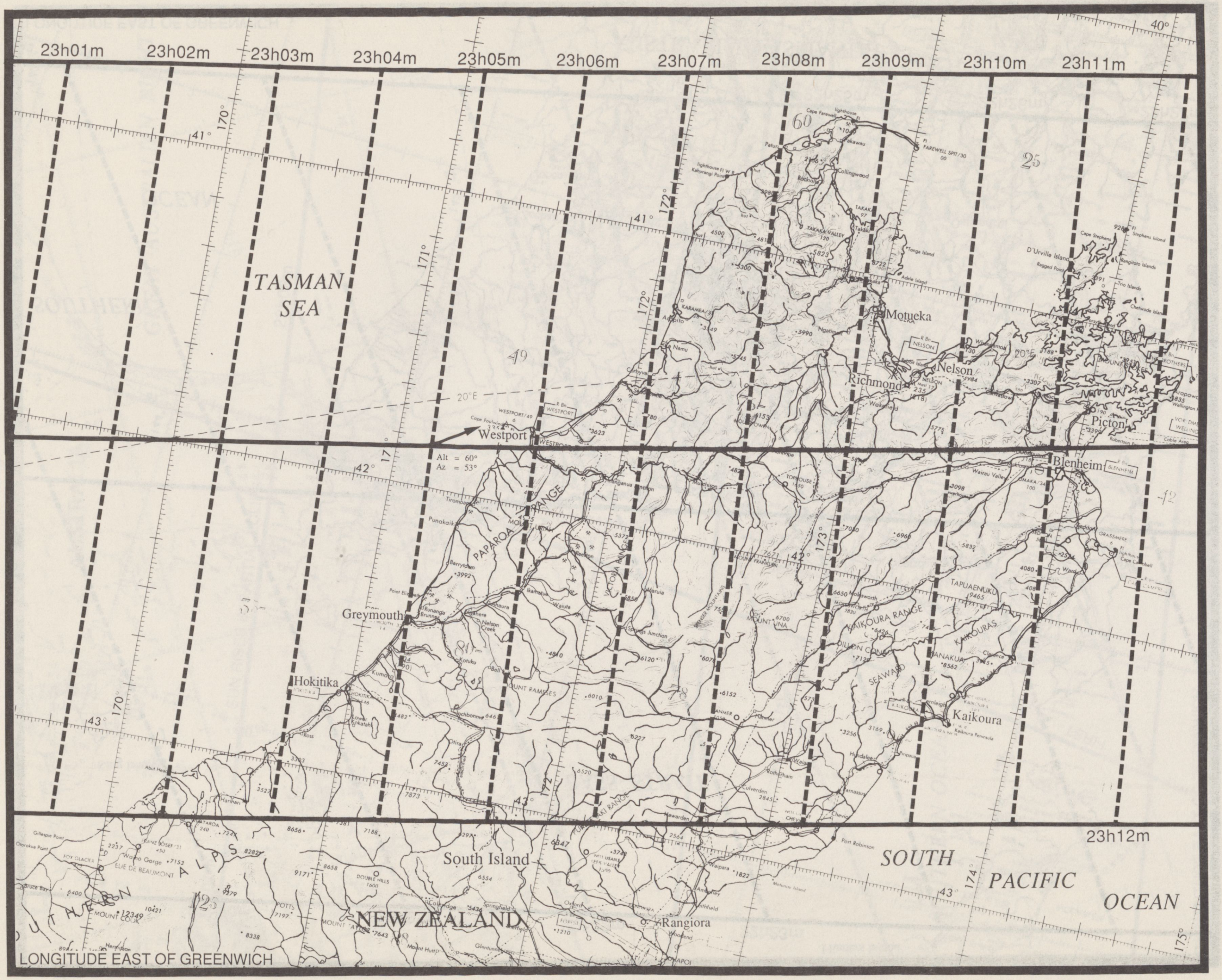
1:1,000,000

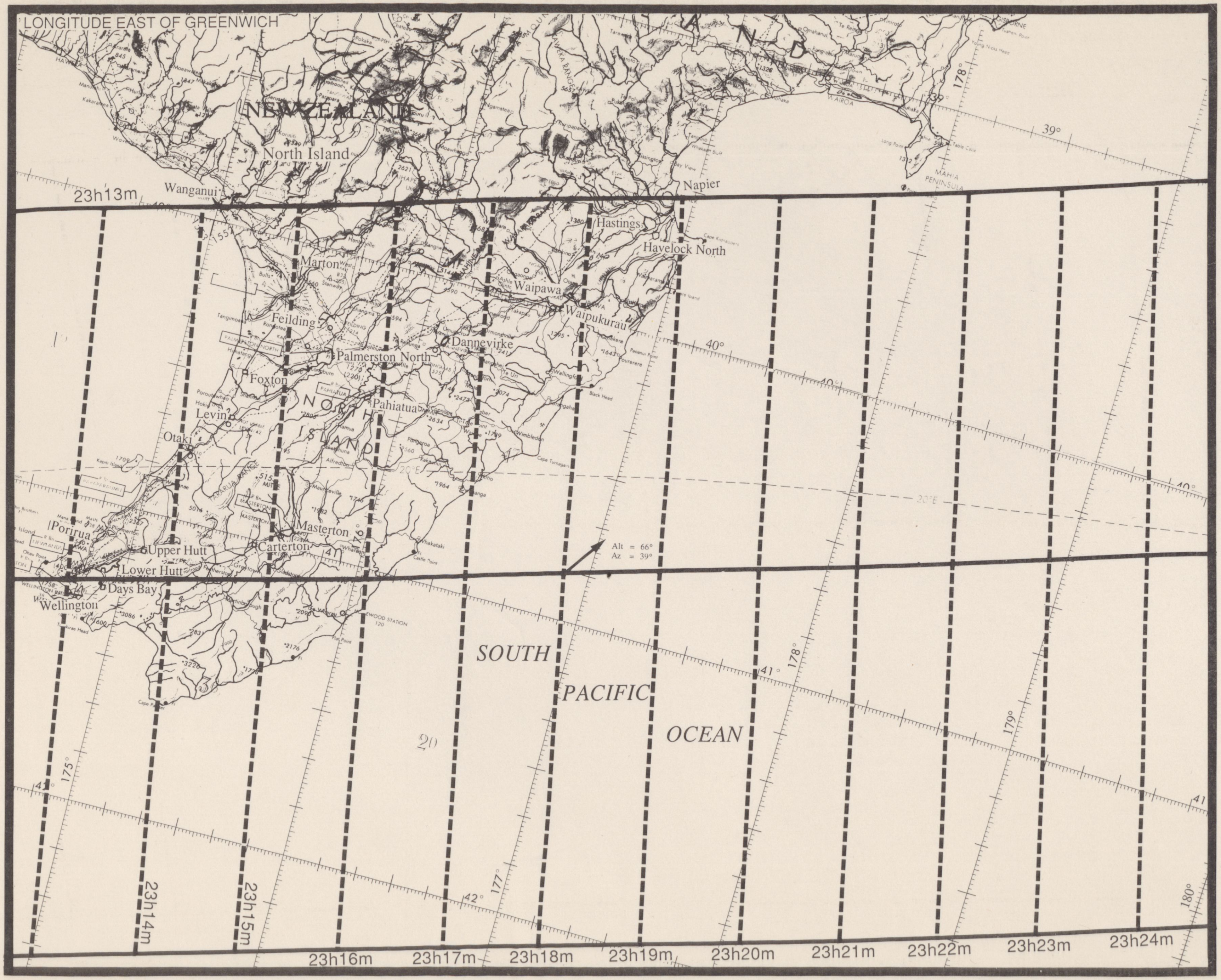

AUSTRALIA
INDIAN OCEAN
21h59m
22h00m
22h01m
22h02m
SUN RISES IN PARTIAL ECLIPSE
Alt = 2°
Az = 113°
LONGITUDE EAST OF GREENWICH
31°
32°
33°
34
114°
115
116°
118°
Northam
York
Corrigin
Perth
Fremantle
Armadale
Medina
Rockingham
Wickepin
Narrogin
Pinjarra
Wagin
Collie
Bunbury
Kojonup
Busselton
Bridgetown
Mandurah
Rottnest Island
Edwards Island
Ledge Point
Cervantes
Moora
Dandaragan
Quinns Rock
Yanchep
Brookton
Pingelly
Boddington
Donnybrook
Capel
Australind
Manjimup
Pemberton
Nannup
Margaret River
Gracetown
Cape Naturaliste
AP/R191
AP/R197
AP/R198
AP/R196


AUSTRALIA
22h00m
32°
22h01m
33°
22h02m
34°
Alt = 11°
Az = 108°
35°
118°
119°
120°
121°
22h03m
SUN RISES IN PARTIAL ECLIPSE
SOUTHERN OCEAN
LONGITUDE EAST OF GREENWICH
Katanning
Mount Barker
Albany
Hyden
Lake King
Ravensthorpe
Jerramungup
Bremer Bay


AUSTRALIA
GREAT AUSTRALIAN BIGHT
SOUTHERN OCEAN
SUN RISES IN PARTIAL ECLIPSE
FIRST CONTACT AT SUNRISE
22h01m
22h02m
22h03m
22h04m
22h05m
Alt = 13°
Az = 107°
ARCHIPELAGO OF THE RECHERCHE
Esperance
Condingup
Scaddan
Truslove
Speddingup
Gibson
Dalyup
Fleming Grove
EASTERN GROUP
WEST GROUP
Point Dempster
Point Malcolm
Cape Pasley
Israelite Bay
SOUTH EAST ISLES
Middle Island
Mondrain Island
Wilson Island
Figure of Eight Island
Beaumont Island
Draper Island
Matthew Rock
Recherche Rock
Westall Island
Douglas Island
Dome Island
Cooper Island
Salisbury Island
Pasley Island
Round Island
Dampier Rock
Middle Rock
Waterwitch Rocks
Termination Island
121°
122°
123°
124°
125°
33°
34°
35°
36°
LONGITUDE EAST OF GREENWICH


22h20m
22h21m
22h22m
22h23m
Flinders Island
BASS STRAIT
King Island
40°
147°
148°
149°
146°
Scotsdale
Wynyard
Beaconsfield
Alt = 34°
Az = 90°
Somerset
Burnie
Devonport
Atrobe
Launceston
Fingal
144°
41°
SOUTHERN
OCEAN
Zeehan
145°
42°
Queenstown
Oatlands
22h24m
22h25m
22h26m
22h27m
Hobart
43°
AUSTRALIA (TASMANIA)
LONGITUDE EAST OF GREENWICH


23h01m
23h02m
23h03m
23h04m
23h05m
23h06m
23h07m
23h08m
23h09m
23h10m
23h11m
23h12m
TASMAN SEA
Westport
Alt = 60°
Az = 53°
Motueka
Nelson
Richmond
Picton
Blenheim
Greymouth
Hokitika
Kaikoura
PAPAROA RANGE
KAIKOURA RANGE
South Island
NEW ZEALAND
Rangiora
SOUTH PACIFIC OCEAN
40°
41°
42°
43°
170°
171°
172°
173°
174°
175°
LONGITUDE EAST OF GREENWICH


LONGITUDE EAST OF GREENWICH
NEW ZEALAND
North Island
NORTH ISLAND
Wanganui
Napier
Hastings
Havelock North
Marton
Waipawa
Waipukurau
Feilding
Dannevirke
Palmerston North
Foxton
Pahiatua
Levin
Otaki
Masterton
Carterton
Porirua
Upper Hutt
Lower Hutt
Days Bay
Wellington
SOUTH
PACIFIC
OCEAN
Alt = 66°
Az = 39°
23h13m
23h14m
23h15m
23h16m
23h17m
23h18m
23h19m
23h20m
23h21m
23h22m
23h23m
23h24m
39°
40°
41°
42°
175°
176°
177°
178°
179°
180°

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